

V. NOTES ON THE RADIATA IN THE MUSEUM OF YALE COLLEGE,
WITH DESCRIPTIONS OF NEW GENERA AND SPECIES. BY A. E.
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Read, Jan. 16th, 1867.

No. 1. *Descriptions of new Starfishes from New Zealand.*

The following interesting species of New Zealand starfishes were sent from Peru by Mr. F. H. Bradley, to whom they were given for our Museum by Henry Edwards, Esq.

They afford a partial illustration of the little known Echinoderm fauna of the Southern Ocean. They contrast strongly with those of the Northern Hemisphere.

Cœlasterias, gen. nov.

Large starfishes, with four rows of ambulacral suckers, and large, swollen rays (eleven in the typical species), which are free to near the base, and are united beneath by a group of interradial plates. Interambulacral plates united directly to the first row of ventral plates, and these to a second row of larger plates without the intervention of open spaces like those seen in *Asterias*. Dorsal surface with large, strong, imbricated, irregularly arranged ossicles or plates, bearing short, very numerous spines.

This genus is more closely allied to *Asterias* (*Asteracanthion*) than to *Heliaster*, and approaches still nearer to *Stichaster*, but appears very distinct from either. The excessive development of the abacinal system over the ambulacral is its most remarkable characteristic. In this respect it contrasts strongly with the next genus. The form and general aspect is that of a *Solaster*.

Cœlasterias australis Verrill, sp. nov.

Rays eleven, in the only specimen seen, large, inflated, rounded, tapering rapidly to the end. Disk of moderate size, swollen; radius of disk to length of rays, measuring from the center, as 2 : 6. The triangular interradial space beneath is occupied by a cluster of irregular stout plates, mostly without spines. Ambulacral grooves relatively narrow and shallow, the pores small and crowded, in four well-marked rows. The interambulacral plates usually bear alternately one and two spines, which are long and rather slender toward the mouth, but short, thick and obtuse toward the end of the ray, and much crowded in indistinct rows. The next row of plates is united directly to

these, and the plates are small, longest lengthwise of the ray, and each bears a short, thick spine, but little larger than the preceding, and forming a regular, rather open row. Exterior to these is another ventral row of large, strong, imbricated, prominent plates, each bearing at its summit two very thick, short, obtuse spines, much larger than the interambulacral ones, and arranged in a single row, and on their external side each plate usually supports two or more short, rounded, much smaller spines, the largest of which usually form a regular row. The plates of the first lateral row are much elongated transversely to the ray, imbricated and strong, and so united to the ventral as to leave large openings between; each bears about twelve small, short, rounded, clavate spines, which are placed along the plates in single or double rows transverse to the ray. The plates of the median dorsal row have a similar form, and bear a similar transverse row of spines, which are somewhat larger. Between these and the first row of lateral plates the plates are irregular in form and arrangement, but short and imbricated, with unequal openings between, forming, about five indistinct rows, all covered with groups of short sub-globular spines, giving an even appearance to the surface, but with large vacant spaces between. Madreporic plate, small, of fine texture, situated a little nearer to the center of the disk than its edge. Minor pedicellariæ few, at the bases of the spines and on the spaces between, longer than broad, obtuse, somewhat compressed, constricted near the base. A few major pedicellariæ, scattered on the dorsal surface and on the interradial surface beneath, are much larger and stouter, with enlarged bases and obtuse tips.

Greatest diameter 11 inches; disk 4; width of rays at base 1.25.

Auckland, New Zealand,—H. Edwards.

Coscinasterias, gen. nov.

Starfishes with many rays, which are elongated, slender, and united only at the base, without interradial plates beneath. Disk small. Ambulacra broad, highly developed, suckers very numerous, in four rows. Spines prominent, arranged in longitudinal rows on the rays. Dorsal surface with large, scattered pedicellariæ. Madreporic plate large, irregular, often with several accessory ones placed irregularly on various parts of the disk. Dorsal plates (ossicles) arranged much as in *Asterias*.

The excessive development of the rays and ambulacral system, compared with the disk or central cavity, is the most characteristic feature of this genus.

The *Asterias aster* Gray, probably belongs to this genus, but is too imperfectly described for identification.

Coscinasterias muricata Verrill, sp. nov.

Rays nine to eleven, slender, tapering, rounded above, flat below owing to the width of the ambulacra, narrowed at the base, five to seven times as long as the radius of the disk, which is small. Ambulacral furrows shallow and broad, with very numerous small suckers, crowded in four rows. Interambulacral plates thin, somewhat imbricated, connected with the lateral plates by a row of small, stout ossicles which alternate with small rounded pores. Each interambulacral plate usually bears a long, slender, tapering spine; these are arranged in a single close row. External to these is a row of distant, longer and stouter cylindrical spines, arising singly from the connecting ossicles between the interambulacral and ventral plates. The latter are strong and imbricated, each usually bearing two longer and stouter blunt spines, which form a crowded double row, along the sides of the arm. Ossicles of the upper surface very stout, bearing strong, acute spines, which are arranged in about five open rows, the median and two external alone reaching the base of the ray; those of the median row are somewhat larger, and all are surrounded by close wreaths of minute pedicellariæ. On the disk they are smaller and loosely scattered, often obtuse. The major pedicellariæ are numerous, scattered over the whole dorsal surface and between the ventral spines, and also form a row within the edge of the ambulacral furrow. They vary considerably in size and form upon different parts. Most of those of the dorsal surface are stout, oval, compressed, pointed, nearly twice as long as wide, about .05 of an inch long, while with them are others of similar form not half as large. Those in the ambulacral furrows are even longer, but more acutely pointed. The madreporic plates are variable in number and size as well as position. One appears to be always in its normal position and near the edge of the disk, while the accessory ones are introduced at various points around the disk, but at about the same distance from the margin. Sometimes, when there are but two and the rays are in even numbers, they are directly opposite and in the same transverse plane. A specimen with eleven rays has two contiguous ones and another separated by four rays, each being composed of several pieces united. One specimen has but one large, convex madreporic plate.

The largest specimen is 7.5 inches in diameter across the rays, with a disk 1.25 inches in diameter; rays .5 broad; interambulacral spines, .15 long.

Auckland, New Zealand,—H. Edwards.

Asterina (Asteriscus) regularis Verrill, sp. nov.

Pentagonal, depressed, with the interradial spaces evenly concave, and the rays short, broad and acute; greatest radius to least as 15 : 10. Ambulacral pores large; interambulacral plates each with two slender acute spines, forming a single row. Those near the mouth larger, obtuse and flattened. Ventral plates of the first row stout and prominent, each bearing a conical, acute spine, twice as large as the preceding. Exterior to these the ventral or interradial plates are flattened and imbricated, diminishing in size as they recede from the center, each bearing an acute conical spine; these diminish in size like the plates, the larger ones being about as thick as the interambulacral spines, but shorter; near the margin these spines become very small and crowded, many of the plates bearing two. Plates of the upper surface rather large, increasing toward the center, regularly imbricated, the free margin evenly rounded and thin, bearing near the end a cluster of five to nine very small, nearly equal spines; toward the center the plates become less regular in form and unequal in size, the larger ones often bearing twelve or fourteen spines in a transverse cluster. Madreporic plate large and prominent, at about one-third of the distance from the center to the margin. The large dorsal pores are in groups on the sides and within the bases of the rays, arranged in about four rows, which run parallel with the median line of the rays, with from six to twelve pores in a row. A few irregularly arranged pores between adjacent rays connect these groups.

Color, when dried, dark olive-green above, yellow below.

From center to end of ray 1.5 inches; to edge of disk .8.

Aukland, New Zealand,—H. Edwards.

Astropecten Edwardsii Verrill, sp. nov.

Rays five, long, regularly tapering, acute, about four and a half times as long as the radius of the disk. Ambulacra broad, interambulacral plates angular, imbricated, each bearing a cluster of three or four slender spines on the inner edge, and two or three smaller ones on the outer angle, not forming regular rows. Ventral plates densely covered with minute rough spines, each having also a central series of sharp spines, the inner ones very small, increasing outwardly to the external, marginal ones, which are strong, sharp and slightly curved upward, a quarter inch long. The lower marginal plates are opposite the upper, and project considerably beyond them. The latter are elevated and narrow, twenty-eight on each side of a ray, the two at the angle between the rays much higher and larger, covered like the rest with rough rounded granules, and each surmounted by a stout, blunt

tubercle. All the others, except the next two, bear a similar, much smaller tubercle, decreasing regularly in size to the end of the ray. The two next the basal one of each ray are thinner than the rest and without a tubercle. Paxillæ largest along the center of the rays, presenting a crowded even surface.

Length of ray from center 2·6 inches; radius of disk ·6; width of ray at base ·7; of median space ·4.

Aukland, New Zealand,—H. Edwards.

No. 2. *Notes on the Echinoderms of Panama and West Coast of America, with descriptions of new Genera and Species.*

The materials for this paper have been derived chiefly from the collections made by Mr. F. H. Bradley, who has spent nearly a year in collecting the marine animals of Panama and adjacent coasts, for the Museum of Yale College, and is still engaged in that exploration. I am also indebted to the Smithsonian Institution for specimens collected at Cape St. Lucas by John Xantus, Esq., and others from Central America sent by Capt. J. M. Dow.

Order, OPHIUROIDEA.

Astrophyton Panamense Verrill, sp. nov.

The largest specimen in the collection is about 13 inches in total diameter, with the disk 1·4. The arms are irregular in their outer divisions, some of the main trunks dividing 19 or 20 times, with very small and slender terminal twigs. The entire surface above and below is closely covered with rather coarse granulations, which are rounded and even on the radial ribs and upper side of arms, but flattened and larger on the lower side of arms, especially at the base; on the interradial membrane they are less crowded, rounded, and unequal. The ten radial ribs are long and narrow (1 inch long and ·15 broad at middle) much raised and prominent, strongly arched, extending to the center, gradually enlarging outwardly to near the end, where they suddenly expand to the end, which is truncate, leaving a transverse cicatrix. Their upper surfaces are slightly convex and have no indications of spines or tubercles, being uniformly and coarsely granulated. The arms are rounded above, with a slight longitudinal groove along the center; the joints are distinctly marked by transverse lines destitute of granules; beneath they are flat and have, also, a slight central depression, and are covered with crowded, pavement-like granulations; tentacle-scales two or three, quite distinct, short, spine-like, commencing at the third or fourth forks; hooks very small, visible only on the terminal twigs. Teeth about eight, strong, blunt-

pointed, diminishing in size outwardly and blending with the teeth-papillæ, which are irregular in number; mouth-papillæ small, 6 or 8 on each side, crowded toward the teeth, leaving the corners of the mouth entirely destitute of them; those farthest from the teeth are much the smallest; madreporic plates prominent, transversely elliptical, twice as long as broad (.13 inch by .06), situated at the edge of the interradiial spaces. The projecting angles of the mouth and a space on the lower side of the arms within the disk and bordering the interradiial spaces all around, is covered with coarse rounded granulations like those of the upper surface. The space around the mouth and connecting with the median area of the arms is granulated like the lower side of the arms. Color, in alcohol, deep umber; when dry, yellowish brown.

The largest specimen, described above, measures as follows:

From angle of mouth to	1st fork of arms,	.72 of an inch.
" " "	2 " "	.87 "
" " "	3 " "	1.25 "
" " "	4 " "	1.65 "
" " "	5 " "	1.95 "
" " "	6 " "	2.30 "
" " "	7 " "	2.75 "
" " "	8 " "	3.10 "
" " "	9 " "	3.40 "
" " "	10 " "	3.80 "
" " "	11 " "	4.05 "
" " "	12 " "	4.40 "
" " "	13 " "	4.65 "
" " "	14 " "	5.00 "
" " "	15 " "	5.20 "
" " "	16 " "	5.52 "
" " "	17 " "	5.75 "
" " "	18 " "	5.95 "
" " "	19 " "	6.10 "

From center to edge of interradiial space .7. Width of rays, at base beneath, .4; of 1st forks .3; of 2nd forks .15; from outer side of madreporic plate to end of teeth .4; to corner of opposite mouth-slit .62; between corners of adjacent mouth slits .22.

A younger specimen, .25 inch from center to edge of interradiial space and .3 to end of radial ribs, has the disk prominently five lobed, the two radial ribs of each arm being separated only by a shallow groove. The first fork of the arms is considerably outside of the disk, .52 of an inch from center of mouth. The arms divide six times. The upper surface is uniformly and coarsely granulated, similarly to that of the larger ones. The lower surface is more uniformly granulated, the disk and region around the mouth presenting nearly the same appearance as the lower sides of arms. The mouth-papillæ are more

slender and relatively longer, and extend nearly to the end of the mouth-slits. The madreporic plate is very small and inconspicuous. The hooks of the arms are more conspicuous and numerous.

Another, much younger specimen, measures from the center to edge of interradial space, .05 inch; to end of radial ribs .1; to first fork of arms .18. The arms divide four times and are long and slender, with numerous hooks; the tentacle-scales extend as far inward as the first fork. The radial ribs do not reach the center, where there is a small, much depressed space; they have the form of five very prominent oblong lobes with a shallow dividing line along the top of each. The whole upper surface is covered with coarse rounded granulations, which are arranged in transverse lines on the arms.

Color of dried specimens, yellowish brown, with traces of lighter bands on the arms.

Panama and Pearl Islands, adhering to *Muricee*,—F. H. Bradley.*

Six specimens of this species, of various sizes, are in the collection.

It appears to be most nearly allied to *A. Caryi* Lyman, of San Francisco, Cal.

Ophiura teres Lyman, Catalogue Museum Comp. Zoöl., I, p. 37, 1865.

This large species is common at Panama and the Pearl Islands, at extreme low-water under stones. About 25 specimens are in the collections of Mr. Bradley.

Some of the larger specimens have rays 5 inches long, with the disk 1.4 in diameter. It is readily distinguished by its stout, round arms, with much broken upper arm-plates. The color is dark olive or purplish brown above, the arm-plates, and sometimes the disk, is thickly speckled with grayish white. Lower side of arms and chewing apparatus light yellowish brown, in life lemon-yellow.

Ophiura Panamensis (Lütken) Lyman, op. cit., p. 32.

Ophioderma panamensis Ltk., Additamenta, hist. Oph., p. 91, 1859.

This species is, apparently, more common than the preceding. Mr. Bradley has sent numerous specimens from Panama. It also occurs at Acapulco (Mus. Comp. Zoöl.), and Cape St. Lucas (Smiths. Inst.).

The larger specimens have arms 4.25 inches long; disk .9 in diameter.

The color is dark greenish gray or brownish above, sometimes with a central light spot; arms similar in color, banded with lighter and darker. Lower surface grayish or greenish white. Mouth-shields rounded, broad-oval; side mouth-shields granulated.

This species is closely allied to *O. teres*. It may be distinguished by its longer, less convex, and more slender arms; by the upper arm-plates,

* Since received from Zorritos, Peru, and Gulf of California, at La Paz,—Reprint.

which are either entire or but little broken,—rarely into more than three pieces, which do not disturb the regular arrangement of the plates; by the radial shields, which are naked in this species and nearly always covered in the preceding.* The arm-spines in this species, near the base of arms, are usually eleven in well grown specimens; in *O. teres* of corresponding size nine, and in the largest but ten. There are, usually, one or two more mouth papillæ in the present species. The mouth-shields of *O. teres* are very broad and short, with a nearly straight outer edge, concave sides, and a rounded lobe projecting inward; in this species they are oval, about as long as broad, very convex outwardly, with a slight, rounded angle inwardly. The under arm-plates are relatively wider than in *O. teres* and somewhat different in form. In the latter the narrow space between the upper genital slits and the arms is covered with granulations like the disk; in *O. Panamensis* it is occupied by narrow naked scales, without granulations.

Ophiura variegata (Lütken) Lyman, op. cit., p. 10 (no description).

Ophioderma variegata Lütken, Vidensk. Meddelelser, March, 1856; Addit. hist. Oph., p. 97.

A much smaller number of this species than of the last was collected by Mr. Bradley at Panama. Dr. Lütken's specimens were from Realejo.

It may be distinguished from the preceding by its covered radial shields, naked side mouth-shields, and oval mouth-shields not so broad as in the last. Upper arm-plates undivided, arms depressed and more slender. It is closely allied to *O. brevispina* of the West Indies. Length of arms 3 inches; diameter of disk .7 of an inch.

The color above is olive-green or greenish brown, with a central blotch and other irregular blotches of reddish scattered on the disk, or sometimes only five, corresponding to the interradian spaces. The arms are conspicuously banded with lighter and darker. The whole lower surface is reddish white.

Ophiura Daniana Verrill, sp. nov.

A depressed species, with short, tapering arms, and partially covered radial-shields. Upper genital openings visible from above, with elevated borders. Side mouth-shields naked. Under arm-plates broad and strongly concave outwardly. Arms speckled above with dark brown, and having a row of distant, circular spots of yellowish-white; beneath white.

Diameter of disk .55 of an inch; arms 2 inches long; .15 wide at base. Mouth-papillæ ten or eleven on each side of the mouth-slits;

* Mr. Lyman describes the young as having naked radial shields. Our specimens, both large and small, have them covered.

outer one longest, pointed, overlapping the next, which is stout, broad, blunt, and larger than the others, which decrease to the sixth and then increase to the innermost; the inner ones are more cylindrical and pointed. Mouth-shields one-third longer than broad; the outer side broadest, rounded; the sides somewhat converging, a little concave, the inner lateral edges nearly straight, forming the acute inner angle. Side mouth-shields naked, triangular, the side next the angle of the mouth concave; one of the corners reaches the genital slit, another the angle of the mouth, the inner ones are widely separated by the mouth-shields. Under arm-plates nearly twice as broad as long near the base of arms; the outer edge regularly and deeply concave; the outer corners prolonged in an acute angle, bounded on each side by short reëntering lines; the inner lateral lines also concave; the inner end regularly convex, about as broad as the concave portion of the outer edge; toward the middle of the arms they become as long as broad, but still have a similar outline. Upper arm-plates nearly twice as broad as long, the outer edge bounded by a slightly convex line, the inner edge by a parallel, concave one, sides nearly straight, converging inwardly. Side-plates encroaching but little. Disk finely and closely granulated, the granules wholly or partially covering the radial shields, and covering the scales at the base of the arms; just outside of the radial shields and about on a level with the upper side of the arms the edge of the disk rises into somewhat prominent verrucæ, perforated at top by the upper genital openings, which are surrounded with elongated, granule-like papillæ. Radial shields large, usually mostly concealed by the granules; the naked part when present is broad oval or nearly round, widely separated, often with scattered granules. Arm-spines ten at base of arms, the upper ones very small, regularly increasing in length toward the lower side of arm to the ninth; the lowest one is a little shorter than the two above it, which are of equal length, and scarcely reach the middle of the next side-plate. The spines are all acute. Tentacle-scales broad and short, the inner one considerably largest.

Color of upper surface when dried, yellowish brown, the arm-plates speckled with dark brown; along the middle of the arm there is a row of distant, small, circular, yellowish white spots, usually divided between two plates; some of the plates also have very small light spots on their outer edges. Lower surface yellowish white, extending upward in points on the sides of the arms at distances corresponding to the dorsal light spots.

La Union, San Salvador, in 6 or 7 fathoms, muddy bottom,—F. H. Bradley. Two specimens.

This species is very different from the others of this region, but resembles *O. variegata* most. The latter has, however, much longer arm-spines, of which the upper are longest; much longer arms; smaller under arm-plates, which are more hexagonal, scarcely broader than long and convex outwardly; the mouth shields are more rounded, broad oval, more prominent, and less acute inwardly; the mouth-papillæ are different in form, the outermost one being shorter and stouter and not overlapping the next; the upper ovarian openings are slits near the base of the arms, beneath, not visible from above. The color also is quite different.

The peculiarity in the form and position of the upper genital openings may hereafter require this species to be separated generically from *Ophiura*, if accompanied by corresponding internal differences in structure.

Ophiolepis variegata Lütken, Vidensk. Meddelelser, March, 1856; Addit., p. 106.

Mr. Bradley has sent specimens of this species, dredged at Panama, of various sizes. From La Union he sent quite a number of very large ones, which came, however, in a badly broken condition. At the latter locality it appears to be abundant, in 6 or 7 fathoms, muddy bottom.

Dr. Lutken's specimen was quite young, agreeing well with some of our smallest ones. The adult specimens present somewhat different characters. It is closely allied to *O. elegans* Lütk. of the West Indies.

The largest specimen from Panama has arms 1.8 inches long; disk .6 in diameter. The mouth-papillæ, eleven to each angle of the mouth, resemble those of *O. elegans*. The outer one on each side is longer and sharper than the rest, quite overlapping the next one, which, like the succeeding three, is short and broad, with a cutting edge. The mouth-shields are more than twice longer than broad, the outer end rounded; the sides reënteringly curved; the inner edge pointed, with nearly straight sides. Side mouth-shields large, quadrangular, the inner sides longest, slightly concave; the inner lateral sides in contact along their whole extent, the outer edge in contact, for three-fourths its length, with the mouth shield, the outer corner projecting into the genital slit; the outer lateral edge is a little concave, exceeding the inner lateral and about equal to the outer edge. Under arm-plates, toward base of arms, twice broader than long, the outer edge concave, the inner convex, the sides strongly concave; along the middle of the arms they are more nearly square; toward the end of the arms they become longer than broad, with a convex outer edge, concave sides and nearly pointed inner edge. Upper arm-plates broader than long, toward base of arms, the outer and inner

edges nearly straight, resembling those of *O. elegans*.* Plates of the disk large, very regularly arranged, precisely like those of *O. elegans*. The central one is nearly circular, surrounded by a rosette of five angular ones with convex inner margins. From the central group a row of the large plates radiate to each interradial margin; to the base of each arm radiates another row of these plates, of which the two outermost are smaller and separate the large, oval radial shields, which are pointed inwardly; between each radial shield and the base of the arm there is also a large angular plate. All the plates of the disk are bordered by a row of very small plates. Arm-spines five at the base of the arms, four farther out, short, tapering, the middle ones longest. Tentacle-scales two, short, broad, the inner one largest.

Color, in alcohol, very variable above; in the specimen above described, dark greenish, with a large central blotch of reddish white surrounded by a narrow line of dark brown; each outer interradial plate is of the same color, with a similar dark border. The other plates, both large and small, are speckled with very dark brown. The upper side of the arms are alternately lighter and darker grayish green, with frequent blotches of reddish white. The lower surface is uniformly white or pale flesh-color. Other specimens have the greater part of the upper side of the disk light grayish green, with blotches of dark brownish green, and a central patch of reddish, which appears to be the constant color of the outer interradial plate. The arms also are at times mostly reddish with irregular patches of green, or they may be very regularly banded with reddish and dark olive-green.

A small specimen with arms .78 of an inch long, and .25 in diameter of disk, has but three arm-spines at the base of the arms and two farther out. Another, somewhat larger, has four spines at base and three along most of the length of the arms.

Some of the specimens from La Union are .9 of an inch in diameter of disk; arms 3.25 long; and have six arm-spines at the base of the arms, of which the uppermost ones are longest.

Ophiozona Pacifica Lyman, op. cit., p. 67.

Ophiolepis pacifica Lütken, Vidensk. Medd., 1856; Additam. hist. Oph., p. 104.

A few specimens of this species have been received from Panama and the Pearl Islands, collected by Mr. Bradley. Dr. Lütken's specimens were from Puntarenas in four fathoms.

Our largest specimen has arms 2 inches long, and a disk .45 in diameter. It was generically separated from the last species on account of the absence of supplementary side pieces to the upper arm-plates. The disk is covered by numerous convex, naked plates, bordered by

* See Catalogue Mus. Comp. Zoöl., Pl. II, fig. 5.

small ones; the central one is largest, nearly circular, surrounded by a rosette of several circles of plates, from which a band of three rows of plates radiates to each interbranchial margin, and a less regular row to the base of each arm between the radial shields; these are longer than broad, pointed at each end, irregular, placed obliquely, and widely separated at the outer edges, which are bordered next to the base of the arms by a large convex plate. The upper arm-plates are quite regular, with nearly straight outer and inner edges, widest outwardly, with slightly concave, diverging sides; near the ends of the arms they become fan-shaped, and the side-plates meet above. Near the base of the arms there are five very short arm-spines, of which the lowest two are slightly longer than the others.

Color, in alcohol, umber-brown above, with slightly indicated bands of lighter brown toward the ends of the arms; below uniformly brown, of a somewhat lighter shade. Young specimens are lighter colored, especially beneath. In another specimen the disk is grayish yellow; upper side of arms the same, with transverse bands of brownish, occupying two or three plates, and an interrupted light stripe, bordered with brown along the middle, formed by a spot of yellowish white on the outer edge of each plate. All the upper plates are mottled with lighter and darker yellowish brown. The upper edge of the side-plates also has a light spot. Beneath uniform yellowish white.

Ophiocoma æthiops Lütken, Addit. hist. Oph., p. 145; Lyman, op. cit., p. 78.

Very abundant at Panama and Pearl Islands, from whence Mr. Bradley has sent about one hundred and fifty specimens. From La Union he has also sent numerous large examples. It occurs also at Acapulco (Coll. Mus. Comp. Zoology), and Cape St. Lucas (Smithsonian Institution).

This species grows to a large size, many of our specimens measuring 8 inches in length of arms; 1.3 in diameter of disk; arms, not including spines, .3 wide; spines .3 long.

It is allied to *O. echinata* and *O. Riisei* of Aspinwall and the West Indies, but differs in the shape and proportions of the arm-spines and mouth-shields, as well as by having flatter arms, etc. In *O. echinata* the upper arm-spines are short, blunt, and remarkably thickened; in *O. Riisei* they are long and slender, like the rest, but considerably longer; in the present species they are stout, the lower ones shorter, and somewhat flattened, the upper ones becoming longer and stouter, the uppermost being considerably thickened. In *O. echinata* the mouth-shields are squarish, with rounded corners; in *O. Riisei* they

are ovoid, the smallest end inward; in *O. aethiops* they are oblong with rounded corners.

The color, both in alcohol and when dried, is a dark, rich brown or almost black above, occasionally with distinct, broad bands of grayish on the outer part of the arms. Sometimes the disk is blotched with grayish white. Lower surface of arms and chewing apparatus grayish brown, rest like upper surface. Young specimens are lighter colored and more conspicuously banded.

Ophiocoma Alexandri Lyman, op. cit., p. 74.

Several specimens of this species were collected by Mr. Bradley at the Pearl Islands, and a single, large one, at Panama. It occurs at Acapulco (Mús. Comp. Zool.), and Cape St. Lucas (Smiths. Inst.).

Our largest specimen has arms about 5.5 inches long; disk .8 in diameter. The color of the upper side, in alcohol, is yellowish brown on the disk; the arms a brighter shade of the same, with unequal transverse bars of dark brown, the lighter colored plates finely mottled with yellowish-white. Lower surface of arms light yellowish brown, with a narrow longitudinal stripe of darker brown passing along each side of the lower plates. Mouth-shields and other parts about the mouth light brownish yellow.

This species may readily be distinguished from the preceding by its relatively longer and more slender arms; by its brighter and lighter colors, and peccular markings on the arms; by its disk covered with little spinose grains; by the arm-spines arranged in rows of five to seven, the third and fourth from the lowest being longest, the upper one smallest; by its nearly round mouth-shields, a little truncated inwardly; and by differences in the form of the upper and lower arm-plates.

Ophionereis annulata Lyman, op. cit., p. 143.

Ophiolepis annulata LeConte, Proc. Phil. Acad., v, p. 317, 1851.

O. triloba Lütken, Vidensk. Meddelelser, 1856.

Ophionereis triloba Lütken, Addit. hist. Oph., p. 112.

This species is very common at Panama and the Pearl Islands, Mr. Bradley having sent numerous specimens. It occurs, also, at Cape St. Lucas (J. Xantus, Smithsonian Inst.) and on the west coast of Central America, whence Dr. Lutken received his specimens. Mr. Bradley collected, also, a few specimens at Acapulco, San Salvador. It lives under stones and in crevices at and near low-water mark.

Our largest specimens have arms 3.3 inches long, the disk .5 broad.

It may be recognized by its long, slender arms, with three rows of spines, of which the middle one is considerably longest. Disk covered

with very small scales, larger around the edge, with small, narrow, elliptical, widely separated radial-shields. Upper arm-plates more than twice as broad as long, broadest near inner edge, with very acute lateral angles, and bordered by broad, triangular, supplementary plates.

Color, in alcohol, varying on the disk from grayish to purplish brown, usually thickly covered with light spots; arms yellowish green or greenish brown with numerous dark purplish brown bands extending entirely around the arms, and often with an interrupted dark line along the middle; lower side yellowish gray, the arms crossed by dark bands.

In one specimen the arms are olive-green above, each upper plate having a small dark brown spot in the middle and another broader one on the inner edge, while the supplementary plates have also a similar smaller spot on the upper edge. The transverse bands have the form of large rounded spots of rich, dark brown, surrounded by a ring of yellowish. The arm-spines are greenish, banded with brown. The arms are yellowish beneath, with transverse bars of reddish brown, occupying two or three plates, corresponding to the large spots above.

In other specimens, also well preserved, the disk and arms correspond in their colors, the disk being clear reddish brown, very thickly spotted with light olive-green, of the same tint as the ground-color of the arms, while the transverse bands of the arms are reddish brown, like the ground-color of the disk, but they are partially interrupted, along the median line, by a faint, yellowish band. One specimen from which part of the arms have been partially or wholly broken and again restored, has the disk and uncast portion of the arms reddish brown, the latter with narrow bands of deep brown, while the restored portions of the arms are olive-green, with broad bands of reddish brown.

Ophiocnida hispida Lyman, op. cit., p. 133.

Ophiolepis hispida LeConte, loc. cit., p. 318, 1851.

Amphiura hispida Lütken, Addit. ad hist. Oph., p. 119.

Two specimens of this curious species have been received from Panama in the collection of Mr. Bradley. The largest measure 3.15 inches in length of arms, and .32 in diameter of disk.

This species is remarkable for its very long, slender arms, and its disk covered above and below by small, sharp spines.

The radial shields are narrow, tapering inward to a point, separated by a spiny strip. There are three short, rounded mouth-papillæ, of which the inner one is largest, on each side of the mouth-slits. Arm-

spines regular, even, in three rows. The upper surface of arms and disk is straw-colored, with narrow transverse bars and irregular spots of deep brown or blackish; under side dull yellowish.

Amphiura geminata Lütken,* op. cit., p. 122

Ophiolepis geminata LeConte, op. cit., p. 318.

Amphiura geminata Lyman, op. cit., p. 180.

Two specimens of this species have been sent from Panama by Mr. Bradley, both of which are injured.

It has long, slender arms, with four rows of spines at the base (in well-grown specimens) and three farther out, of which the middle one is largest and bluntest and somewhat rough. There are three mouth-papillæ on each side of the mouth-slits, of which the outermost is broader than both the others. Mouth-shields lance-shaped, with the inner end acute. Lower arm-plates pentagonal, broader than long, with one angle turned inward. Disk covered by small even scales, a little larger toward the edge of disk. Radial shields narrow, pointed inwardly, in contact, except at the inner ends, which are separated by a scale.

According to Mr. Lyman, a specimen had arms 1.4 inches long, with a disk .16 in diameter. Our specimens are somewhat smaller, but have the arms broken. They are, in alcohol, yellowish white, with a few small, light brown spots on the upper arm-plates.

Amphiura violacea Lütken, Vidensk. Meddelelser, 1856; Addit. hist. Oph., p. 123.

In the collection from Panama there is a small specimen, apparently identical with this species. Dr. Lütken's specimens were from Realejo.

According to Dr. Lütken, it has the following distinctive characters: Mouth-shields small and lance-shaped; side mouth-shields large and triangular; under arm-plates as long as broad, and separated, like the upper plates, which have the same form as those of *A. microdiscus*† Lüt., but are less broad, by the side arm-plates. Diameter of disk 2^{mm}.

Amphiura Puntarenæ Lütken, op. cit., 1856; Addit. hist. Oph., p. 123.

A single specimen from Panama, too imperfect for description, is doubtfully referred to this species. Dr. Lütken's original description is as follows: The mouth-shields are a little longer than broad, and

* This and the other species here named *Amphiura* belong to the genus, *Amphipholis* Ljung,—Reprint.

† *A. microdiscus* Lütken, was described as follows: Disk small, arms thick, but thin at base; upper arm-plates twice as long as broad, outwardly slightly and inwardly strongly curved; lower arm-plates as long as broad, without an indentation; diameter of disk 1^{mm}. Puntarenas, 10 fathoms.

have rounded but very prominent side-angles, so as to become nearly heart-shaped; lower arm-plates longer than broad, having a slight incurvature on the outer edge; upper arm-plates regularly oval, not much broader than long; the disk has a diameter of 2^{mm}; the slender arms a length of c. 20^{mm}. Puntarenas, in 3 fathoms.

The two preceding species and *A. microdiscus* are very small species allied to *A. squamata* M. and Tr., and all have the radial shields joining each other completely; mouth-shields lengthened, rhomboidal; outermost mouth-papilla broader than the other two; lower arm-plates pentagonal with an angle turned inward; upper arm-plates transversely oblong; arm-spines three in number.

Two other species, *A. Örstedii* Lützk., from Puntarenas, and *A. marginata* Lützk. (*Ophiophragmus marginatus* Lyman) from Realejo, I have not seen.

Hemipholis gracilis* Verrill, sp. nov.

A delicate species, closely allied to *H. cordifera* Lyman, with long, slender arms; arm-spines in three rows, tapering, thickened at base; mouth-shields broad pentagonal, with rounded corners; under arm-plates octagonal with rounded corners; a single tentacle-scale.

Arms about nine times as long as the diameter of disk. Mouth-papillæ two to each mouth-slit, situated at the outer lateral edge, slender, somewhat elongated, blunt. The mouth-slits, or spaces between the jaws, are broad and regularly heart-shaped, the indentation in the outer side formed by an acute, triangular projection from the inner arm-plate, which is mostly concealed by the side mouth-shields, which meet above it. The two inner tentacles are situated on each side of this pointed inner angle of the first arm-plate, and within the mouth-slits. Mouth-shields a little broader than long, somewhat pentagonal, the outer edge nearly straight, the outer lateral edges short, the lateral angles rounded, the inner lateral sides longer, somewhat curved and forming a rounded inner angle. Side mouth-shields elongated transversely, meeting in front of the mouth-shields, and also across the arms so as to form a continuous ring around the mouth; the inner side is concave, the outer has a central, projecting, acute angle, extending to the lateral angle of the mouth-shield. Under arm-plates somewhat octagonal, broader than long, toward the base of the arms the outer and inner edges are nearly straight, the lateral edges are composed of three short sides, with rounded angles between, which farther out on the arms become merged into a curved lateral line.

* *H. affinis* Ijungman, Ophiur. viventia, Ofv. af Kgl. Vet. Akad. Förh., May (?), 1867, p. 322, appears to be identical with this,—Reprint.

The second, third and fourth plates have a somewhat different form, the outer edge being broader than the inner, and the sides concave. Upper arm-plates broad and somewhat irregular-oval, about twice as broad as long, the inner edge much more strongly arched than the outer, which, on some of the plates near the base of the arms, is slightly concave in the middle. Side-plates encroaching but little above and scarcely any below, except toward the ends of the arms. Arm-spines three, nearly equal, a little thickened near the base, round, slender, tapering, but not sharp. Tentacle-scale oblong, flattened, rounded at the end, hardly twice as long as wide, standing free from the sides of the lower plates, except at the second and third from the base, where they are shorter and in close contact with the lower arm-plates.

Disk, above, covered with unequal, rounded, overlapping scales; a larger, round, central, primary plate is surrounded by smaller ones, and then by five primary ones about as large as the central one, each of which is surrounded by a few smaller scales; from these five a row of primary plates, bordered on each side by smaller imbricated scales, radiates to each interbrachial margin. Radial shields pear-seed-shaped, with the point inward, the outer side strongly arched, the inner sides in contact at the outer end, separated inwardly by three scales, of which the most exterior is elongated and narrow and the most interior broad, rounded, the intermediate one somewhat triangular. Between each radial shield and the base of the arm there are two or three scales and a small papilla-like spine, not one-fourth as long as the arm-spines. Lower side of disk destitute of scales, but bearing minute, scattered granules.

Color, in alcohol, light greenish gray above, darker and more distinctly greenish toward the ends of the arms, which are banded with whitish; radial shields and primary disk-plates green; beneath white, chewing apparatus yellowish.

An average specimen has the arms 1.38 inches long with the disk .17 in diameter. One of the larger is .2 in diameter of disk; the arms, though broken at the ends, 1.8. The largest is .22 in diameter of disk.

Panama,—F. H. Bradley. Eight specimens, 4 fathoms, muddy bottom.

This species very closely resembles *H. cordifera* of South Carolina, which has the habit of living buried in mud at low-water mark and thrusting out of its burrow one of its long slender arms. It differs, however, in the form of the mouth-shields and lower arm plates, as well as in several other particulars.

Ophiactis Lütken.

Of this genus there have been described four nominal species from the Panamic Province, besides one from Peru. Of these, it is probable, as has been suggested by Mr. Lyman, that *O. Örstedii* Lütken, is a synonym of *O. simplex* (LeConte sp.), no differences yet indicated being sufficient to separate them clearly.

The species of *Ophiactis* may be recognized by their rather short arms and stout disk, covered above with overlapping scales and a few, small, scattered spines; usually with separated radial shields. There are commonly four to six rows of arm-spines, which are rough, short, and stout, projecting at right angles from the arms. There is but one tentacle-scale and but one or two mouth-papillæ on each side of the mouth-slits. The species are mostly small and often have six arms.

Ophiactis Kroyeri Lütken, Vidensk. Meddelelser, 1856; Lyman, op. cit., p. 108.

Mr. Bradley has sent several hundred specimens of this species from Callao, Peru, where they were found in abundance among the interstices of *Balani*, *Discinæ*, *Mytili*, etc., scraped from the bottom of a vessel that had been a long time in that port. Some of the largest specimens have arms 1.7 inches long and the disk .35 in diameter. Of this species I have seen no specimens having six arms.

The color varies considerably, but most frequently is dull greenish, in alcohol, with a few irregular bands of purplish brown upon the arms; beneath grayish or greenish white. Some specimens are purplish brown above, with bands of greenish on the arms, and others are yellowish gray, with or without bands of darker. Frequently the upper arm-spines have a spot of white at base. The radial shields are usually darker green or brown than the rest of the disk, and have a yellow spot on the outer end and are sometimes edged with white, or have a white spot at the inner end. In other specimens the radial shields are yellowish with a greenish disk. The disk may, also, be mottled with lighter and darker.

The number and size of the spines upon the disk are also quite variable. In some cases they are nearly or entirely absent, while in others they are quite numerous, long and sharp, scattered all over the disk, except on the large radial shields; more frequently, however, they are mostly confined to the interradial spaces of the disk, and are rather few in number. The radial shields are large, acute-triangular, with the point inward and a prominent, elevated lobe on the corner where they join their neighbors; the inner ends are separated by about four plates, of which the outermost is very narrow and the innermost rounded. The mouth-shields are short and broad, with an elongated,

acute point outwardly and a slight angle inwardly. The side mouth-shields are elongated transversely and do not meet within. Mouth-papillæ one on each side of the mouth-slits, short and stout. Lower arm-plates rounded octagonal; upper plates broad-oval, a little overlapping, most convex outwardly. Arm-spines five, the middle one longest.

Callao, Peru,—F. H. Bradley. The specimens of Dr. Lütken and Mr. Lyman came, also, from the same place.

Ophiactis virescens Lütken, op. cit.; Lyman, op. cit., p. 113.

This species may readily be recognized by the upper arm-plates, which are twice as broad as long and have a distinct, projecting lobe in the middle of the outer edge. The arms are somewhat narrowed at the base and very slender at the ends. Under arm-plates as long as broad, octagonal. Mouth-shields roundish rhomboidal, with an angle inward. Two small mouth-papillæ on each side of mouth-slits. Five or six arm-spines, short and stout, rough, upper two longest. The disk-scales bear a few scattered spines, which are sometimes wanting.

Color yellowish green, with narrow dark green bands on the arms, beneath greenish gray. The radial shields are dark green and often have a light spot on the outer ends.

Our specimens all have six arms, except the very young, which lack three, on one side. The largest has arms .75 of an inch long, with a disk .15 in diameter. Another has arms .4 inch, with the disk .12.

Panama, clinging to Gorgoniæ and sponges. Occasionally adhering among the arm-spines of *Ophiothrix spiculata*,—F. H. Bradley. It occurs at Puntarenas and Realejo,—Dr. Lütken; and Cape St. Lucas,—J. Xantus, (Smiths. Institution).

In one instance I found, in a small cavity of a branching sponge from the Pearl Islands, upwards of fifty specimens of this species, of various sizes, but mostly young. Thirty-seven were quite small, and light colored, and although many had six equal arms, others, of similar size, had three upon one side, very small, appearing as if just starting to grow, or entirely wanting. From this mode of occurrence it is probable that this species, like some *Amphiure*, is ovo-viviparous.

In this lot were two specimens differing considerably from all the others. These are among the largest, and have the arms narrowed at base; seven arm-spines, upper ones longest; large radial shields, covering a large part of the disk; broad upper arm-plates, convex outwardly, and destitute of a distinct lobe, or with only a slight central prominence, except near the ends of the arms, where a small, distinct lobe is visible. In most other respects they agree well with

the ordinary form, except that the color is light yellowish gray above, with greenish radial shields and an undefined greenish spot on each upper arm-plate, the tips of the arms faintly banded with greenish; yellowish white beneath. Diameter of disk .17; length of arms .75 of an inch.

Ophiactis simplex Lütken; Lyman, op. cit., p. 105.

Ophirolepis simplex LeConte, Proc. Phil. Acad., v, p. 318, 1851.

? *O. Örstedii* Lütken, Vidensk. Meddelelser, 1856; Addit. Ad. Hist. Oph., p. 129.

Eight specimens of this species occurred with the last, from Panama.

The species may be distinguished by the small, widely separated radial shields; rounded and regular disk-scales, with very few small spines, except beneath, where they become more numerous; arms longer and more slender than those of the preceding species; mouth-papillæ prominent and flat, one upon each side of the mouth-slits.

The mouth-shields are transversely rhomboidal, with an angle within and without. Five short arm-spines, of which the three middle ones are longest. Upper arm-plates broad-oval without a lobe.

Color greenish, with lighter bands on the arms.

In all our specimens there are six arms. They agree very nearly with *O. Örstedii* Lütken,* which came from Puntarenas.

Ophiactis arenosa Lütken, op. cit., 1856.

There are a few young specimens, found with the last two species, which appear to represent a third species. Whether they belong to the present one or not is somewhat uncertain, owing to their immaturity.

Mr. Lyman places this species as a doubtful synonym of *O. simplex*. Our specimens are insufficient to determine this question satisfactorily.

According to the original description by Dr. Lütken, its characters are as follows: "*O. arenosa* Lüt. Mouth-shields roundish; one mouth-papillæ; upper arm-plates broad-oval; under arm-plates rounded, quadrangular, a little broader than long; four short arm-spines, of which the two middle are the longest.

* Dr. Lütken's original description is as follows: *O. Örstedii* Lüt. Mouth-shields broad rhomboidal; one mouth-papilla; five arms; upper arm-plates broad-oval; lower arm-plates octagonal, a little broader than long; five short arm-spines, of which the three middle and longest are only as long as one of the arm-joints.

Color green, with bands upon the arms.

Diameter of disk 4mm. Length of arms 18mm. Puntarenas.

The color seems to have been about like that of the two preceding (*O. Örstedii* and *O. virescens*).

Diameter of disk 5^{mm}; length of arms 20^{mm}.

Puntarenas and Realejo."

In addition to the preceding species of *Ophiactis* there is a single imperfect specimen that may belong to an undescribed species.

It has larger radial shields than *O. simplex*, separated by a row of about three scales, no spines apparent on disk; five arm-spines, the upper one very short, the middle one longest; upper arm-plates short, transversely oblong, nearly three times broader than long, with nearly straight outer and inner edges and slightly rounded sides; mouth-shields rounded; one mouth papilla on each side of mouth slits; under arm-plates somewhat octagonal, outer edge convex.

It has about the size and proportions of our largest *O. virescens*, but has no lobe on the outer edge of upper arm-plates and differs in other particulars. It is probably nearest to *O. simplex*.

The color is dark greenish above.

Until more specimens have been examined, it appears undesirable to apply a new name to this form.

Ophiothrix spiculata LeConte, op. cit., p. 318; Lyman, op. cit., p. 167.

This species is very abundant at Panama and the Pearl Islands, clinging to sponges, Gorgoniae, etc., whence Mr. Bradley has sent upwards of two hundred specimens. He has also sent it from Realejo, Nicaragua, and Acajutla, San Salvador. It occurs from low water to 4 fathoms.

Our largest specimens have arms about 3 inches long, and the disk .5 in diameter.

The color, in alcohol, is usually light cobalt-blue or bluish purple, often with every fourth or fifth lower arm-plate red or brownish. Some specimens have spots of red on the disk and more or less on the upper side of the arms. In life the color is described as fuscous above and paler beneath; or greenish with violet upper arm-plates, and occasional red plates on the lower side of the arms.

It is allied to *O. violacea* of Aspinwall and the West Indies,* but differs in having longer arm-spines and in several other characters.

The disk usually has the centre and a band radiating to each inter-brachial margin and to the base of each arm covered with numerous, very short, branching spines, with more or less numerous, long, slender, thorny spines scattered among them. The arm-spines are long and slender, thorny, the next to the upper one longest.

* Recently separated from the Brazilian *violacea* and named *O. Caribæa* by Lütken.—Reprint.

Ophiothrix (*Ophiothela*) *mirabilis* Verrill, sp. nov.

A small species with six arms, granulated above; disk mostly covered by the large radial shields, and in the longer specimens with central and interradial groups of simple, short, conical spines; arm-spines short, directed downward, armed with hooks. Teeth-papillæ about ten, rounded, arranged in an oval group. Mouth-shields and side mouth-shields closely united to the surrounding parts, so as to form a continuous ring around the mouth, covered with a skin which conceals their outlines, the side mouth-shields about as large as the mouth-shields. Under arm-plates about as long as broad, widest outwardly, the outer edge convex, the sides converging to the rounded inner angle, separated by the side arm-plates, and covered, like the mouth-shields, with a naked skin, which obscures their outlines even in dry specimens. Side arm-plates well developed, bearing upon the very prominent sides about five tapering spines, of which the uppermost is quite small, the next and longest about equal to the width of arm, the others decreasing in size to the lowest, which is very small. When six spines occur the third is the longest. Toward the base of the arms the spines are minutely thorny near the ends, the thorns being chiefly on the lower side of the spines, irregular, and often curved; toward the middle of the arms and beyond, the thorns become more numerous, larger and curved into well-marked hooks. Disk nearly covered above by the twelve prominent, elongated radial shields, which reach nearly to the center and are narrow and blunt at the outer ends. They are in contact, except along the inner portion, where they are slightly separated. Their surface is minutely pitted and more or less covered by scattered, unequal, rounded granules. Between the radial shields and at the center, the surface is covered by a distinct skin, without visible scales. In the interbrachial spaces at the margin of the disk there is a cluster of about six sharp, conical spines, without thorns. A cluster of similar spines sometimes occupies the center. In young specimens the spines are absent. The upper arm-plates are concealed by the skin, which is covered by numerous, rough, unequal, rounded grains, the intervals between the plates being indicated by narrow, transverse, naked spaces.

Color, in alcohol, quite variable, usually dark. One specimen has the disk grayish brown, the outer ends of radial shields bright yellow; the arms with narrow bands of grayish white, bright yellow, and black; beneath yellowish brown, the under arm-plates minutely speckled with dark brown. Another has the disk, above, deep reddish brown, with a lighter center; the outer ends of the radial shields yellowish white; the upper side of arms transversely banded with dark brown and yellowish white.

A medium-sized specimen has arms .5 of an inch in length, with the disk .16 in diameter; the two largest yet examined have the disk .22 in diameter. It is quite probable that all these specimens are young.

Pearl Islands, Bay of Panama,—F. H. Bradley.* Among the interstices of a branching sponge, associated with two species of *Ophiactis*, about a dozen specimens of various sizes were found. Others occurred in colonies clinging to the branches of *Gorgonia* and *Muricea*, with the arms wound closely around the branches.

Subgenus, *Ophiothela* nov.†

The name *Ophiothela* is here employed to designate a group of Ophiurians, of which the preceding species is the type, agreeing together in having the upper arm-plates covered with granulations as in *Astrophyton*; in having short, rough arm-spines, mostly turned downward, and armed with roughnesses or hooks, beneath, as in *Ophiactis*; in having very large radial shields, covering most of the disk, the intervening spaces being covered with a skin and bearing simple spines; in having the lower side of arms and disk covered with a skin, more or less obscuring the plates; and in having the mouth-shields and side mouth-shields united into a ring around the mouth. The present species and another from the Feejee Islands have, in the numerous specimens observed, always six arms, and have the same habit of clinging closely around the branches of *Gorgonia*.

In the structure of the mouth it agrees well with the typical species of *Ophiothrix*, but it differs in having the arms distinctly covered with a membranous skin, and their upper surface granulated; and in the character of the spines of the arms and disk, which lack the glassy appearance and prominent thorny branches, and approach more nearly those of *Ophiactis* in form, structure, and arrangement. Although intermediate in some respects between *Ophiothrix* and *Ophiactis*, it is evident that these species are more closely allied to the former genus, under which I have placed them as a subgenus.

Additional Remarks on Ophiuride.

Owing to the small number and imperfect condition of our specimens of some of the species of *Amphiura* and *Ophiactis* I have been obliged to leave them somewhat in doubt and, in order to avoid producing any confusion, have in such cases preferred quoting the original descriptions instead of giving new ones. This seemed still more

* More recently from Cape St. Lucas and La Paz,—Reprint.

† This has since been regarded as a distinct genus (p. 376). Besides this species and *O. Dana* V., Feejee Is., a species occurs on *Mopsella* from Japan (Dall), and *Paris* from Formosa (Lütken),—Reprint.

desirable, since the original descriptions by Dr. Lütken are somewhat inaccessible in this country and have not been translated before.

In the identification of some of the species I have had important assistance from Mr. W. H. Niles, of the Sheffield Scientific School.

In the preceding pages I have enumerated all the species of Ophiurans which we have hitherto received from the Panamic Zoölogical Province, with the exception of an apparently undescribed species of *Ophiura* allied to *O. Panamensis*, and as yet represented by only four specimens.*

The following species, which I have not seen, have been described from the same coast:†

Ophiostigma tenue Lütken—Realejo, West Coast of Central America.

Ophionereis Xantusii Lyman—Cape St. Lucas.

Amphiura microdiscus Lütken—Puntarenas.

Amphiura Örstedii Lütken—Puntarenas.

Ophiophragmus marginatus (Lütken) Lyman—Puntarenas and Realejo.

Ophiothrix dumosa Lyman—Gulf of California.

* The specimens referred to have rather slender arms, subcarinate above; radial shields mostly covered, the naked part being oval, widely separated; mouth-shields oval, the narrowest end inward, about as long as broad; side mouth-shields covered; mouth-papillæ eight or nine on each side of the mouth-slits, the innermost and three outermost stoutest; under arm-plates as long as broad, somewhat octagonal, with a slightly convex outer edge and concave sides; arm-spines eight to ten, the lowest one considerably longest; the others decreasing in length to the uppermost, which is quite short.

Color, above, dark olive-green, the disk finely speckled and the arms conspicuously banded with greenish gray, the upper arm-plates with irregular longitudinal dark streaks, and numerous light spots; lower surface yellowish white, the dark bands of the arms passing entirely around, but lighter beneath.

It appears to differ from *O. Panamensis* in having only eight or nine mouth-papillæ instead of from ten to twelve; in the outermost of them being much smaller than the next, instead of projecting beyond it; all of them being relatively larger and less crowded; the tentacle-scales being less unequal in length; the arm-spines more unequal, stouter, and more acute; in the somewhat coarser and less crowded granulation of the disk; in the larger and less sunken radial shields (which are nearly covered, however, in young specimens); and in the coloration. The outer and inner genital slits appear to be nearer together and the inner ones more transverse.

Notwithstanding these differences, I have deemed it best not to give a new name to this form until more numerous specimens can be examined.

Our largest specimen is .75 of an inch in diameter of disk.

† *Amphipholis grisea* Ljung., Guayaquil, appears to be an additional species, — Reprint.

Order, ASTERIOIDEA.

Luidia tessellata Lütken.

Luidia tessellata Lütken Vidensk. Meddelelser, 1859, Bidrag til Kundskab om de ved Kysterne af Mellem- og Syd-Amerika levende Arter af Søstjerner. p. 16.

Several specimens of this species, of various sizes, were obtained by Mr. Bradley at Panama, and one small one at Acajutla. Dr. Lütken's specimens came from Puntarenas and Realejo.

Our largest specimen measures, from the center of disk to tip of rays, 6.5 inches; to border of disk 1 inch; width of rays at base, not including spines, 1.1. A medium sized specimen measures 3.4 inches from center to end of rays; and .6 to edge of disk; rays .7 wide at base.

The rays are depressed and taper regularly to the ends, which are more slender in the small than in the large specimens. The interambulacral* plates bear a slender, sharp, and strongly curved spine on the inner edge, and more externally a group of three or four longer and stouter ones, of which the inner stands singly, the two next side by side, and the outer, when present, singly. The ventral plates are covered with numerous unequal, minute, sharp spines and bear a central row of eight to ten small, stout spines, and usually three long, sharp, marginal ones, which are somewhat curved in the direction of the ends of the rays, and longer than the interambulacral spines (.3 of an inch in large specimens). The upper surface is crowdedly covered with elongated paxillæ, which are much larger along the sides of the rays than in the middle and upon the disk, where they become very small and close. Those of three marginal rows on each side are considerably largest and somewhat quadrangular, bearing at the top a central group of six to ten small, short, blunt, or rounded tubercles, surrounded by numerous, fine, slender, diverging papillæ. Toward the center of the rays and on the disk, they usually bear only one or two small, rounded tubercles, surrounded by similar papillæ.

The color of a dried specimen is yellowish green above and yellow beneath; in alcohol, brownish green above, yellowish beneath.

This species is allied to *L. clathrata* of Florida and the Carolina coast, but has broader and less slender rays; much longer and stouter interambulacral spines; more spinose ventral plates; and much larger and more numerous marginal spines; the paxillæ are not so short and thick, and bear fewer and larger central tubercles.

* We use the term "*interambulacral*" to designate the first row of plates bordering each side of the ambulacral furrows of starfishes, believing, as Prof. Agassiz has shown, that they are strictly homologous with the interambulacral plates of *Echini*.

Dr. J. E. Gray has given the name, *Petalster Columbiæ*, to a species from "St. Blas," collected by H. Cuming, which is, apparently, allied to this, but which cannot be the same if correctly described. The diagnosis, which is too imperfect for reliable identification, is as follows: "Rays elongated, slender, gradually tapering; tubercles short, with crowded groups of rather large, acute spines, and a fringe of very fine radiating ones."

In *L. tessellata* the rays are certainly not slender, when compared with other species of the genus, and the "spines" on the paxillæ are not acute.

It is probable that Gray's species has not yet been rediscovered, as is the case with many other starfishes described by him from the collections made by Cuming, on the same coast. But if intended for the present species, the description is so inapplicable and imperfect that it cannot be deemed sufficient to characterize it.

Astropecten fragilis Verrill. sp. nov.

A thin, depressed species, with slender, acutely tapering rays, which, measuring from the center, are about four and a half times the radius of the disk. A specimen measuring 2.3 inches from center to tip of ray has about 40 marginal plates. Each interambulacral plate usually bears three slender spines at the inner edge, the middle one being longest, and outside of these a single longer and stouter, pointed spine. The lower marginal plates are covered on their lower side with sharply pointed spinose granulations and bear numerous small sharp spines, mostly along their outer edges. At the margin these become larger and longer, each plate bearing three or four spines which may be considered marginal, of which the uppermost is usually longest. These are round, rather slender, tapering and acute, slightly curved outward, diminishing gradually in size toward the tip of the ray. The upper marginal plates are low and quite short, those at the interradial angle being shortest, those toward the tip of the rays becoming very small. These are coarsely granulated and destitute of spines or tubercles, except three or four of those at the base of the rays, which, in the larger specimens, bear at the inner edge a small, rounded tubercle, most prominent on the interradial pair of plates, which are also somewhat higher than the rest. The dorsal area is about one and a half times the width of the marginal plates. The lower marginal plates are but little produced beyond the upper.

One of the larger specimens measures 2.3 inches from center to tip of rays; .5 to edge of disk; width of ray at base .6; its dorsal area .4;

height of broadest upper plates $\cdot 1$, length $\cdot 07$; length of longest marginal spines $\cdot 15$.

Panama, at extreme low-water on sand, and Zorritos, Peru,—F. H. Bradley.

A specimen measuring 1.3 inches from center to tip of rays agrees closely with the preceding description, except in lacking the small tubercles on all the upper plates, even at the base of the rays. It has 30 marginal plates.

This species is, in many respects, allied to *A. regalis* Gray, of which I add a description for comparison, but is nevertheless remarkably distinct in form and many other important characters.

Astropecten regalis Gray, Ann. and Mag. Nat. Hist., vi. p. 178, 1840.

A depressed species with broad, short arms, a little contracted at base, scarcely acute. Radius of rays to that of disk at 3 : 1. A specimen 1.5 inches from center to tip of rays, has 23 marginal plates.

The interambulacral plates bear three slender spines at the inner edge, of which the central is nearly twice as long as the others, and outside of these a single, sharp, much stouter, but scarcely longer, spine. The lower marginal plates are closely covered with even, flat-topped granulations, and bear along the outward border from 5 to 8 nearly equal, small, conical spines, and at the upper margin, usually, two large, flattened, blunt or lanceolate spines, which are largest toward the base of the rays, but quite small in the interradial region. They are mostly channeled upon the upper side and convex beneath. The upper marginal plates are low and rather short, closely covered with unequal rounded granules, those upon the middle being largest and, on the plates toward the tip of the ray, enlarging into small rounded tubercles, two, three, or four standing in a transverse row along the middle of the plate. The plates on the basal portion of the ray are destitute of tubercles or spines, in both of my specimens, but older specimens may, perhaps, attain small tubercles even to the base of the ray, since there are fewer on the younger specimen. The dorsal area of the rays is broad, with fine paxillae. The lower marginal plates project considerably beyond the upper.

The larger specimen is 1.5 inches from center to tip of ray; $\cdot 48$ to edge of disk; width of ray at base $\cdot 5$, of dorsal area $\cdot 3$; length of longest marginal spines $\cdot 18$.

Panama,—F. H. Bradley; San Salvador,—Capt. J. M. Dow (Coll. Smiths. Institution).

It is quite probable that the *Astropecten calacanthus* Martens,*

* Monatsb. der Akad. der Wi-s., Berlin, Jan., 1865, and translated in Annals and Mag. Nat. History, vol. xv, p. 435, 1865.

may be the more mature condition of this species. It agrees in most of the characters, except in having small tubercles on all the upper marginal plates and in the character of the spines of the lower surface. In form and the peculiar character of the marginal spines, it agrees very closely. This specimen was considerably larger (radii of rays 49^{mm}; of disk 17^m) and came from Costa Rica.

Gray's original description of this species,* which, though very brief, agrees, quite well with our specimens, is as follows: "Upper plates spineless, lower produced." "Rays one-fourth longer than the diameter of the body, broad, tapering; spines broad, stout, depressed." "Like *A. marginatus*, but the arms are shorter and broader." San Blas,—Mr. Cuming.

Astropecten Örstedii Lütken, Vidensk. Meddelelser, 1859.

Rays moderately long, rather broad at base, tapering regularly to the acute ends. Greatest to least radii as 5 : 1. A specimen measuring 3 inches from the center to the end of the rays has 36 marginal plates. Interambulacral plates each with an inner row of three slender spines, of which the central is a little longer than the others, and outside of these a single, large, blunt spine, which is somewhat flattened, and nearly twice as long as the inner ones. Exterior to these the same plates bear several slender, short spines. Lower marginal plates broad, projecting a little beyond the upper, closely covered with short, blunt, spicula-like spines, and bearing a transverse series of five or six strong, sharp spines, which bend somewhat toward the tip of the ray. The first of these spines are of about the same length as the larger interambulacral, toward the margin of the ray they increase in length, the longest being .35 of an inch long and very strong and sharp. The uppermost row is irregular and the spines smaller. The upper marginal plates are narrow and high, the two basal ones of each ray bearing a large, conical, sharp spine, .2 inch or more long; all the others, two subequal, smaller spines, of the same shape, which form two regular rows. Central region of the rays covered with paxillæ, which are longer and less crowded than in most species. Around the center of the disk some of the paxillæ have a cen-

* This species may be at once distinguished from the preceding by its broad, short rays, which do not taper to long slender points, by the broader disk and dorsal area of rays, by the stouter spines of the lower plates, which are flattened and rather blunt, instead of round and sharp, and by the even granulation of the lower surface, and much less spinose character, which gives it a smoother appearance. The small tubercles of the upper plates, also, are more developed toward the tip of the rays, while in the preceding they appear only at the base.

tral acute spine, rising above the general surface. Madreporic plate large, very near the marginal plates.

Length of rays from center of disk 3 inches; to edge of disk .6; width of rays at base .65; of central, dorsal area .4 of an inch.

Panama,—F. H. Bradley.

A small specimen in the collection of the Smithsonian Institution, apparently belonging to this species, collected at Cape St. Lucas by J. Xantus, presents the following peculiarities: Radius of rays 1 inch, of disk .3. The rays have the same form as in the preceding. The upper marginal plates are narrow and rather high, formed as in the large specimen; there are 20 on each side of the rays; the two occupying the interradial angle bear, each, a single long sharp spine; the next three or four bear two smaller spines, while the remaining plates, even to the end of the ray, bear a single small spine. The lower marginal plates are closely granulated and each usually bears five or six spines, of which the three lower are short and sharp, and the two upper long, round, sharp, and somewhat bent, resembling, except in size, those of the larger specimens.

Dr. Lütken's specimens are intermediate in size between the two preceding, and differed from the large specimen, above described, chiefly in having the inner row of upper marginal spines confined to the inner three to eight plates, instead of extending nearly to the tip of the rays.

Astropecten Peruvianus Verrill, sp. nov.

Rays narrow, elongated, acute, with the angle between somewhat rounded. Greatest to least radii as 5:1. In a specimen two and a half inches from the center to tip of rays there are 34 marginal plates. Interambulacral plates each with three slender spines at the inner margin, of which the central is much the longest; exterior to these each plate bears a somewhat stouter, blunt spine, of about the same length, and several very small spines. The lower marginal plates project but little beyond the upper, each bearing about five small, sharp spines, the three lower being shorter than the inner interambulacral, the two upper considerably longer and larger (about .1 of an inch long). The upper marginal plates bear, each, a small conical spine at the inner edge, and several of those toward the ends of the rays have also a very small spine on the central part. Dorsal area of the rays narrow, depressed at the middle of the ray, somewhat exceeding the width of a marginal plate. Madreporic plate small, about its own diameter from the marginal plates.

Length of rays, from center, 2.5 inches; to edge of disk .5; width of rays at base .5 of an inch.

Païta, Peru,—F. H. Bradley; Dr. C. F. Winslow (Boston Soc. Natural History).

Whether *A. stellatus* Gray, is identical with this species cannot be determined by his very imperfect description, which applies equally well to several other species.

His description of *A. stellatus* is as follows: "Rays more than twice the diameter of the body; narrow central area of the rays equal to one series of marginal tubercles. Coast of South America?"

Müller and Troschel place this, with doubt, as a synonym of *A. Valenciennesii* M. and Tr., Vera Cruz.

Patiria obtusa Gray, Proc. Zoölogical Soc. London. 1847, p. 72.

In the collection of Mr. Bradley* there is a specimen, which I refer to this very imperfectly described and hitherto obscure species.

Greater radius .95 of an inch; smaller .60. From pentagonal, with regularly concave sides; rays short, rapidly tapering and somewhat obtuse at the end; upper side convex. The ambulacral grooves are deep and narrow, bordered by rounded interambulacral plates, which bear four or five long, rather slender spines in a single row, of which the one next to the outermost is usually the longest, and the one nearest the mouth considerably the shortest. Outside of these and parallel with them is another row of spines of about the same number, form, and size, and borne upon plates of similar character, which are connected with the inner row, and directly opposite to them. The ventral plates of each triangular area, toward the mouth, bear from four to six slender, sharp spines, a little shorter than those along the ambulacral grooves, placed in a single transverse series on each plate, or sometimes in a crescent-shaped group; toward the margin of the disk the plates and spines rapidly diminish in size, each plate bearing three or four very small and slender spines, mostly placed transversely side by side. The margin is formed by a row of small rounded plates, without a sharp edge, and closely covered with minute granule-like spines. The dorsal surface, near the margin between the rays, is covered with small, close, uniform plates, which bear closely crowded, circular or rhomboidal clusters of minute papilla-like spines, which are subdivided at the end into microscopic radiating points. The plates increase in size toward the central area, and at a short distance from the margin become crescent-shaped and separated by the dorsal pores, with other much smaller rounded plates between them, each of which bears a small rounded cluster of small spines, similar to those borne by the larger plates, which are longer toward

* The locality is uncertain, probably Panama, but perhaps Païta,—Reprint.

the center than upon the plates near the margin, but have the same character. These thorny spines in the central region are still very small and slender, two or three times longer than thick, and form densely crowded, large, crescent-shaped, or small rounded groups, according to the shape of the plates. The crescent-shaped plates extend along the middle of the rays to near the tip, and are accompanied everywhere by the dorsal pores, which are large and numerous. There is a small central area, occupied by small rounded plates, with pores between them, at the edge of which is placed the small madreporic plate, composed of but few convolutions. A narrow band, extending from the central area toward the margin, in the middle of each interradiation region, is destitute of pores.

Color, in alcohol, yellowish-red.

The original description by Dr. Gray is so brief and imperfect as to render the identification of this species somewhat uncertain. It is as follows: "Brown, depressed, 5 or 6 rayed; rays depressed, rounded at the end; dorsal surface with lunate ossicles crowded with short spines; oral surface with circular groups of crowded spines in the middle of each ossicle. Panama, 6 to 10 fathoms."

This description, so far as it goes, agrees tolerably well with our specimen, except that the groups of spines on the oral surface cannot properly be called "circular." In this case, as in many others, Dr. Gray does not mention the size of the specimens described, so that no account can be taken of variations due to difference of age, which are often very great among starfishes.

Asterina (Astericus) modesta Verrill, sp. nov.

Form pentagonal with slightly concave edges and broad, very short, rounded rays. Radii as 7:5. The interambulacral plates bear three or four small, slender spines, forming a single row along the ambulacral grooves. The ventral plates each bear one or two sharp spines, a little larger than the preceding, in the region near the mouth, and more numerous and much smaller ones near the margin. Margin thin and sharp, with a fringe of minute sharp spines, 6 or 8 to each plate. The dorsal surface is covered with imbricated plates which are finely granulated, and each bears upon its upper margin from 5 to 15 minute sharp spines. The plates rapidly increase in size from the edge of the disk to the central region. Dorsal pores in five imperfect rows along each ray and many scattered about the central region of the disk. One of the larger specimens measures .35 of an inch from center to end of ray; .25 to edge of disk.

Panama and Pearl Islands,—F. H. Bradley.

Oreaster occidentalis Verrill, sp. nov.

A large species, resembling in form and character of the upper surface *O. gigas* Lütke. (*O. reticulatus* M. and Tr.), but less spinose above and not at all so beneath; marginal plates without spines, or only a few near the ends of the rays. Greater to smaller radii as $2\frac{1}{4}$: 1.

The largest specimen has a greater radius of 4.3 inches; smaller 2. Another has the radii respectively 3.8 and 1.7 inches. Form pentagonal, with a large, elevated, angular disk, and narrowed, rather slender, short rays. The margin between the rays is regularly and deeply incurved, without a distinct angle. The interambulacral plates bear an inner row of slender spines, seven or eight on each plate near the center, and four or five toward the end of the rays, the middle ones longest, the others decreasing in length on each side to the outer ones, which are quite short, thus forming pointed groups. Outside of these there is a second row of much larger, short, flat, blunt spines, three to each plate on the inner and only two on the outer portion of the rays, the middle one, when there are three, being a little the longest and considerably largest, but when there are but two the one nearest the mouth is usually, but not always, largest. The ventral surface is destitute of spines and covered with coarse, irregular, crowded, unequal granules, among which there are scattered numerous, sessile, two-lipped pedicellariæ, with narrow, elongated openings. In one specimen the ventral plates, especially near the mouth, have a central group of larger, elevated granules, some of which become twice as high as thick, with a somewhat acute point, thus approaching the character of small spines. On each side of the rays are 18 lower and 17 upper marginal plates in the larger specimen, and one less of each in the smaller. The lower plates belong entirely to the ventral surface and are covered with coarse granules similar to those of ventral plates, becoming finer and more uniform at the outer margin. They all bear numerous small, oblong-oval, sessile pedicellariæ, and in the largest specimen are destitute of spines and tubercles, but in the smaller, from two to four of the plates nearest the end of the rays bear small, stout, obtuse spines or tubercles, which are surrounded at the base by granulations, but naked above. The upper plates, which form the margin, are thick and convex, rather rounded, much longer than those of *O. gigas*, closely covered with small, angular, convex granules like those of the whole upper surface, among which there are numerous, scattered, sessile, pedicellariæ, like those of the lower plates. In the larger specimen none of them bear spines, but in the other there are from one to four that bear small, short, stout, blunt, conical spines near the ends of the rays. The upper surface of the arms and disk i

reticulated with elevated plates and connecting ossicles, as in *O. gigas*, which bear at most of the nodes or intersections small, conical; naked spines of unequal size, each on a large conical tubercle, which is granulated. Around the central area there is a well-marked pentagon, with a large conical tubercle at each angle, corresponding to the rays, and a small one on each side, opposite the interradiar region. Within this pentagon there are four spine-bearing tubercles around the slightly convex anal region, and a few others irregularly placed. From the angles of the pentagon a row of large, spine-bearing tubercles, from fifteen to twenty in number, extends along the middle of each ray. The spaces between the reticulations of the upper surface are pierced by very numerous pores, among which there are many small oval pedicellariæ. Other similar, but more elongated, pedicellariæ are frequent on the spine-bearing tubercles. Madreporic plate small, fine, situated considerably outside of the dorsal pentagon. Color, in alcohol, grayish brown; in life the dorsal plates are bright crimson, the spaces between, greenish brown.

Panama, two specimens, dredged, in 6 to 8 fathoms,—F. H. Bradley.

This species is allied to *O. gigas* of Florida and the West Indies, but the latter has larger and more numerous spines on the upper surface; much smaller upper marginal plates, each bearing a conical spine; more coarsely granulated lower marginal plates; ventral plates bearing one or two short conical spines; outer row of interambulacral spines formed by much larger and longer, subacute, stout spines, one to each plate, instead of flat, thin, truncate spines standing two or three to a plate, as in *O. occidentalis*. The pedicellariæ of the ventral surface are very much smaller and different in form, those on the marginal plates are less numerous and more rounded.

Under the name of *Pentaceros Cumingii*, Gray has briefly described a very small specimen, which may, possibly, have been the young of this species, but none of the characters given are applicable to our specimens, and the presence of marginal spines in so small a specimen, when they are almost entirely wanting in large ones, is a character which seems to render their identity extremely improbable.

Gray's description is as follows: "The arms are rather narrow, nearly as long as the diameter of the body; marginal spines few, small; back rather depressed, with conical protuberances, bearing small spines. Diameter 12". Perhaps the young of a much larger species."

Punta Santa Elena, rocky ground, 12 to 18 fathoms,—H. Cuming.

Nidorellia.

This name was applied by Dr. J. E. Gray* to a section of his genus *Pentaceros* (*Oreaster* M. and Tr.), which included only the following species. Although the character of having movable spines, which he attributed to it, seems not to exist, it has so many important differences from typical *Oreaster*, in external form and structure, which we must suppose to be connected with still more important internal peculiarities, that it appears worthy of being separated as a distinct genus.

Until a comparative study of the internal structure shall have been made we can only indicate some of the more important external peculiarities for distinctive generic characters.

Such are the broad depressed disk, the short, broad, depressed rays, rounded at the ends; the elevated margin, with large plates, those at the ends of the rays largest and swollen.

Nidorellia armata Gray.

Pentaceros (*Nidorellia*) *armatus* Gray, Ann. and Mag. Nat. Hist., vol. vi, p. 276, 1840.

Oreaster armatus Müll. and Tr., System der Asteriden, p. 52, 1842.

Goniodiscus armatus Lütken, op. cit., 1859, p. 75 (p. 51 of pamphlet).

Oreaster armatus Lütken, op. cit., p. 148, 1864; E. von Martens, Monatsb. Akad., Berlin, 1865, and Ann. and Mag. Nat. Hist., xv, p. 433, 1865.

Numerous specimens of this species were collected by Mr. Bradley at Panama and the Pearl Islands, and Zorritos, Peru. It occurs on the reefs at low-water. Prof. B. Silliman has, also, presented two specimens from Panama. It is also found at Realejo and Puntarenas,—Dr. Lütken; Punta Santa Elena,—Dr. Gray; Gulf of Nicaragua, Costa Rica,—Dr. E. von Martens.†

Our largest specimen is 6·5 inches in diameter, the smaller radius being 2·75 and the greater 3·25.

The specimens vary greatly in the number and arrangement of the large conical spines; and in the spines of the marginal plates, which may be numerous, both above and below, or entirely absent. The pedicellariæ are also very variable, sometimes being entirely absent, while other specimens have numerous large, two-lipped ones, near the mouth or scattered on the lower surface, and smaller ones on the lower marginal plates, or even on the upper ones. All these variations are too inconstant to allow the species to be divided into varieties. Sometimes the extreme variations are found on the different rays of the same specimen. The number of spines of the dorsal sur-

* Annals and Magazine of Natural History, vol. vi, p. 275, 1840.

† Capt. Pedersen has recently sent several large specimens from La Paz,—Reprint.

face and of the marginal plates increases with age, though not regularly, since some specimens of large size have fewer than others, which are much smaller. I have not yet seen two specimens that agree in the number of the spines.

One specimen, which may be considered as representing the *average condition* of adult specimens, has the following characters. Form pentagonal, with regularly incurved sides and short, broad, rounded rays. Greater radius 3.3 inches; smaller 2.2. Dorsal surface a little convex. Interambulacral plates, near the mouth, bear five or six flat, blunt, slender spines, forming a single row, the two middle ones longest; toward the end of the rays there are but three, of which the middle one is the longest. Outside of these there is a row of very stout, thick, rounded spines, with obtuse ends, arranged one opposite each cluster of the interambulacral spines, those near the mouth largest, the size diminishing to the end of the rays, where they become small and more pointed. The ambulacral furrows turn upward at the end of the rays and terminate between the swollen upper plates, between which there is, also, a small plate, bearing a small conical tubercle. The lower surface is covered by coarse rounded granulations, that become finer and closer toward the marginal plates, which they completely cover, and bears numerous, regularly arranged, short, stout, blunt, conical spines or tubercles, which also decrease in size from the center to the margin. Among these are scattered many short, stout, oblong, two-lipped pedicellariæ, which are more numerous near the center, but vary greatly in number upon the different rays. The lower marginal plates belong chiefly to the ventral surface, except near the end of the rays, where they form more of the margin. There are eight of these to each side of a ray, all are convex, those in the interradial spaces being smaller than those toward the end of the rays, except the last one, which is smaller than any other and somewhat triangular. Each of these plates bears a short, stout, conical spine larger than those of the lower surface. The upper marginal plates, which form the greater part of the margin, are somewhat irregular in number and form, there being either seven or eight upon each side of the rays, of these the four nearest the end of the rays, on each side, are about as long as broad, very convex, the last one largest and swollen, joining its mate on the other side of the ray. The six or seven plates that occupy the interradial portion of the margin are less convex and much broader than long, one or two of them bearing near the lower side a stout conical spine. Each of the four outer plates of the margin, except one of the outermost ones, bears a similar conical spine; these are mostly larger than those of the lower plates. In the

center of the upper surface there is a stout conical spine upon a tubercular prominence, and around it are ten similar spines, five of which correspond to the interradial spaces and five to the rays, and from the latter a row of five or six similar spines extends along the median line of each ray. In the interradial regions of the upper side there are from three to five similar spines placed irregularly. The spines of the upper surface and margin are smooth and naked, except at the base, which is surrounded by a ring of crowded, polygonal, flat-topped granules, like those that cover the general surface. More than half of the upper surface is covered by large groups and clusters of pores, which occupy all the intervals between the plates and often blend together into large patches on the rays. Among the pores are scattered very numerous, small, short and stout, oblong pedicellariæ. A few similar, but somewhat larger pedicellariæ occur upon the lower marginal plates, either singly or in small groups. The madreporic plate is large ($\cdot 3$ of an inch in diameter), slightly convex, of fine texture, placed about an inch from the center, just outside of one of the ten spines that surround the central area.

The largest spines in this specimen are $\cdot 28$ long and $\cdot 15$ in diameter at base; they are united to the plates by a suture, which readily separates, when the specimens are not well preserved, leaving a smooth depression, but they do not appear to have been movable.

Color, in alcohol, deep reddish brown above, yellowish brown below. When living, bright scarlet, (F. H. Bradley).

Some of the more prominent variations from the preceding condition are as follows:

2d. A specimen with the greater radius $2\cdot 3$ inches. Pedicellariæ of lower surface smaller and less numerous; marginal plates seven above and below on each side of the rays, less unequal in size and form, with small pedicellariæ, very numerous on many of the upper plates, less so on the lower; lower plates mostly bearing conical spines, but some having a group of three or four small rounded tubercles instead; upper plates mostly without spines or tubercles, one ray having two spine-bearing plates near the end on one side, another having two on each side, but not on corresponding plates, the rest without any; a few plates with groups of small tubercles, apparently where spines have been broken off. Upper side with a central large spine and a row of three or four spines along each ray, no spines in the interradial region.

3d. Greater radius $2\cdot 5$ inches. Similar to the last, but the marginal plates are nearly destitute of pedicellariæ, and the lower ones all bear a spine, while the upper ones, except one or two near the ends of the

rays are without spines or tubercles. Four of the interradial regions of the upper surface have each a single large spine near the margin, and one of them also a small one inside the madreporic plate; the fifth has no spine.

4th. Greater radius 3 inches. Lower surface with very few large pedicellariæ, eight lower and seven upper marginal plates, the outermost two the most swollen; all the lower plates bearing a spine; two or three of the upper ones near the ends of the rays bearing small spines, and many of them with a few scattered pedicellariæ. Central dorsal spine surrounded by ten spines, and only one of the interradial regions having a spine near the margin. Five or six spines along the middle of the rays.

5th. A specimen of the same size as the last. Lower and upper marginal plates without tubercles or spines, except two or three of each at the end of each ray, which bear small spines; most of them bearing scattered, large, oblong, sessile pedicellariæ. Interradial regions with from four to seven large, sharp spines.

6th. The largest specimen, with the greater radius 3.75 inches. Lower surface nearly destitute of pedicellariæ, a few very small ones on most of the upper marginal plates. The latter are more uniform in size and shape than usual, from three to five of the outermost bearing small spines, the rest without spines or tubercles, except that one of the middle ones, on three of the interradial margins, bears a spine. Central dorsal spine surrounded by ten spines, with two other spines irregularly placed within the ring. The median row of spines along the rays has from seven to ten spines. The interradial regions bear from nine to thirteen spines in unequal, but somewhat regular, groups.

7th. A specimen, having the greater radius 3.3 inches, has groups of from six to eight interambulaeal spines in the inner row. Each of the interradial spaces beneath bears from two to six stout, unequal, irregularly placed pedicellariæ. There are eighteen lower and sixteen upper marginal plates along each interradial margin, all of which are destitute of pedicellariæ. Each of the lower ones bears a short, blunt spine, largest near the end of the rays. The three upper plates nearest the ends of the rays alone bear spines, the rest are evenly granulated. There are from seven to nine spines along the median ridge of the rays and from four to six, regularly placed, in the interradial regions. Besides the usual ten spines around the central one, there are four others, forming an imperfect inner circle around it and corresponding to four of the radial rows.

Goniodiscus stella Verrill, sp. nov.*

Form pentagonal, with short, acute rays, and regularly concave sides. Radius of rays to that of disk as 8:6. Marginal plates, in a specimen one half inch from center to end of rays, five on each side of rays, those above and below corresponding. These plates are squarish, about as broad as long, diminishing regularly to the tips of the rays. The interambulacral plates bear each three or four short spines of which the central one is slightly longer and larger; these form a single range along the groove. Outside of these there is a row of slightly longer and much stouter, flattened, oval, blunt spines, which do not reach the end of the rays. The ventral plates are closely granulated, those nearest the margin bearing one and sometimes two small rounded tubercles on the center. The marginal plates, above and below, are closely and finely granulated; the two of the lower series, next the end of the rays, bear each a small rounded tubercle. The dorsal surface is covered by very regular hexagonal plates, which are covered by rounded, unequal granulations, coarser and less crowded than those of the margin. These plates are nearly flat and each is surrounded by six pores, placed at the angles, except a few of those opposite the angle between the rays, which lack a part of the pores. The central area is surrounded by five somewhat larger plates, corresponding with the interradi al spaces, and by five others a little more prominent outside of these, alternating with them and corresponding with the rays, which have, along the central line, a row of plates that are a little more prominent, but not appreciably larger than those of the general surface. The annus is central, surrounded by fine irregular plates. Color, in alcohol, grayish yellow.

The only specimen seen, which is probably young, is .48 inch from center to end of rays; .3 to edge of disk; length of largest marginal plates .08; diameter of medium sized dorsal plates .05 of an inch.

Cape St. Lucas, Cal.,—J. Xantus (Coll. Smithsonian Institution).

Since the above has been put in type, another large specimen has been sent us from Zorritos, Peru, by Mr. Bradley, agreeing in most of its features with the one described, but having characters that cause it to approach *Nidorellia armata*. This specimen, therefore, leads me to suspect that both may, possibly, prove to be the young of the latter.

The Zorritos example measures, from the center to end of rays, .72; to edge of disk .48. Six plates on the sides of the rays, above and below. Most of the ventral plates bear a small rounded tubercle; the larger spines of the row outside the ambulacral grooves are stout,

* This has since been ascertained to be the young of the preceding species,—Reprint.

short, and flattened, diminishing to the end of the rays. The outermost two, lower, marginal plates bear a small rounded tubercle. The plates of the upper surface are regularly arranged, polygonal, surrounded by from six to ten pores, and bearing oblong, sessile pedicellariæ, which do not rise above the granules; five of the plates around the center, corresponding to the median line of the rays, are more prominent and bear short, thick, round-topped, naked tubercles, forming a pentagon; from these a line of ten plates extends along the middle of each ray, a few of them bearing one or two very small, rounded tubercles. The middle of the disk is a little more elevated than in the smaller specimen.

Linckia.

We follow Dr. Lütken in retaining the name *Linckia* (Nardo, in part) for the group having the *Asterias lævigata* Linn. as its type, not deeming its previous use in Botany a sufficient reason for rejecting it. This genus corresponds nearly with *Linckia* of Gray and includes the typical species of Nardo. It corresponds with the section *b* of *Ophidiaster* in the "System der Asteriden" of Müller and Troschel. *L. unifascialis* departs considerably from this generic type, and may ultimately require separation.

For the genus *Ophidiaster* we take *O. ophidianus* Agassiz, as the type, as most authors have done. Thus it corresponds to the group as restricted by Gray and by Lütken, and nearly to the section *a* of Müller and Troschel.

For the group typified by *Asterias variolata* Lam., we have adopted Gray's name, *Nardoa*, which has two years priority over *Scytaster* of Müller und Troschel, and has the same species for its type, although some additional species were added to it by the latter authors. This group corresponds in part to *Linckia*, of Nardo and of Agassiz, and to *Scytaster*, as restricted by Lütken.

Linckia unifascialis Gray.

Linckia (Phataria) unifascialis Gray. loc. cit., 1840.

Ophidiaster (Linckia) unifascialis Lütken; Kritiske Bemærk. om forskj. Søstjerner, Vidensk. Meddelelser, 1864, p. 165.

? *Ophidiaster suturalis* Müll. and Troschel, System der Asteriden, p. 30, 1842.

We have received a large number of specimens of this species from Panama and the Pearl Islands, and Zorritos, Peru, collected by Mr. Bradley, and from Cape St. Lucas, collected by J. Xantus for the Smithsonian Institution. Dr. Gray's specimens were collected by Hugh Cuming in the Bay of Carracas, on rocks at low water. Dr.

Lütken received his specimens from Cape St. Lucas through the Smithsonian Institution, and one from Acapulco from the Museum of Comp. Zoölogy.

The disk is small and the rays are slender, slightly tapering, rounded-triangular. Proportion of radii as 7 or 8:1. The mature specimens of average size have the greater radii 3.7 inches; the smaller .5; width of rays at base .5.

The interambulacral plates bear an inner double row of short, crowded, papilla-like, alternately unequal spines, and an outer row, close to the inner, of similar form, but stouter and nearly uniform in size. The plates are placed obliquely and each one bears on its inner side a very small blunt spine, and a little more outwardly and to one side, a much stouter one, which is flat, broad and truncated at the end, but narrowed at base, and so arranged that the smaller ones stand within and appear to alternate with them. On its outer portion each plate also bears a still larger and stouter, but scarcely longer, truncated spine, forming the outer row. The lower side of the rays, outside of the interambulacral plates, is formed by four or five rows of small, squarish, equal, and regularly arranged plates. Beyond and joining these along the sides of the rays there is a row of similar plates, but more than twice as large. Above these, and occupying about half the width of the sides of the arms, there is a continuous longitudinal belt of pores, without intervening plates. Along the middle of the arms there is a wide belt of irregular, angular, crowded plates, larger and more convex than those of the lateral rows. The plates are everywhere covered with similar, crowded, coarse, rounded granules, which are largest near the ambulacral grooves. The poriferous belts are covered with finer, rounded granules. The madreporic plate is large, irregular in form, adjacent to the convex, central, anal area.

Color, in alcohol, light yellow or reddish.

I am unable to find anything in the description of *Ophidiaster suturalis* M. and Tr. by which it can be distinguished from this species. Its origin was unknown.

A somewhat larger specimen, without authentic locality, presented to the Boston Society of Natural History by Mr. Horace Mann, differs in having the lateral poriferous region divided into two, for one or two inches from the base of the rays, by a row of plates like those of the dorsal series, with which they unite outwardly, forming thus a wider region of plates without pores on the outer part of the rays. This specimen has also three madreporic plates, regular and normal in structure. The inner interambulacral plates, near the base of the

rays, form only a single series, alternately larger and smaller, the larger ones broad, flat, truncated. Outside of these a row of larger ones, similar in form, but much stouter.

This form, which does not appear to be a distinct species, may be *Linckia bifascialis* Gray. It occurs, also, at Cape St. Lucas.

Ophidiaster pyramidatus Gray.

Ophidiaster (Pharia) pyramidatus Gray, Ann. and Mag. Nat. Hist., 1840.

Ophidiaster porosissimus Lütken, op. cit., 1859.

Mr. Bradley has sent numerous specimens of this species from Panama and the Pearl Islands. We have also received specimens from the Smithsonian Institution collected at Cape St. Lucas by J. Xantus. Dr. Gray's specimens came from the Bay of Caraccas, West Columbia, on rocks,—Hugh Cuming. Dr. Lütken received his from Puntarenas. It therefore has, like the last species, a range extending through the whole extent of the Panamic Zoölogical Province. It occurs on the reef at Panama, with the last, at extreme low-water of spring tides, among rocks.

The original description by Dr. Gray is as follows: "Rays subangular, elongate, nearly four times as long as the width of the pyramidal body, with seven rows of tubercles; the central dorsal series much the largest; spines near the ambulacra ovate, subacute."

Our numerous specimens show that the pyramidal form of the body is merely due to the state of preservation, the specimens in alcohol showing little or nothing of this character, while in a part of the dried specimens it is pretty well marked.

The ratio of the greater to the smaller radius is as 7 or 8 : 1. A specimen, with rays 4·6 inches long, has the radius of the disk ·6; width of rays at base ·7; elevation of dorsal surface of disk ·9.

The rays are rounded, somewhat swollen, tapering very slowly to the thick, obtuse, rounded ends. The rays, in small specimens, and those that are in the process of restoration after being broken, have more acute tips.

The interambulacral plates bear two elongated, blunt spines on the inner edge, of which the one nearest the mouth is a little longer than the other and twice as thick, flattened and subclavate at the ends. These form a single, crowded row of alternately larger and smaller spines along the edges of the ambulacral furrows. Outside of these there is a row of distant, short, stout spines, blunt at the ends and narrow at the bases, which arise from the outer part of every second or third plate. Joining the outer edges of the interambulacral plates there is a close row of stout, somewhat convex plates. At intervals

of one or two of these plates transverse series of two or three or more smaller plates connect this row with a similar row of larger convex plates along the sides of rays, thus leaving oblong spaces which are occupied by numerous pores. Three other longitudinal belts of similar poriferous spaces, alternating with rows of convex plates, occupy the sides of the rays, while along the dorsal median line there is a broader, irregular, often double row of larger and more irregular plates.

The whole surface, above and below, is covered by coarse, short, convex granulations, with other minute ones intervening. Sessile pedicellariae, with oval openings, scarcely raising above the granules, are scattered on the lateral plates, and numerous smaller ones occur among the pores. They often have the slit divided across the middle, so as to appear double.

Color, in alcohol, dark grayish or yellowish brown, when dry, often tinged with purplish brown above. In life variegated above with purple and brown.

Mithrodia Bradleyi Verrill, sp. nov.

Disk small; rays five, round, elongated, not rigid; dorsal surface coarsely reticulated and covered with numerous, small, scattered, papilliform spines, and with a median and about three lateral rows of large, stout spines, roughened, like the small ones, with small spinule-like granulations.

Radii as 7 : 1. Length of rays from the center 4.3 inches; radius of disk .6; width of arms at base .6, somewhat enlarged farther out; length of longest spines .25, diameter .08. The interambulacral plates bear an inner row of very slender, small, sharp spines, from five to seven to each plate, the middle ones longest, forming rounded clusters, in which the spines are connected together by a web to the ends; and close to these, on the outside, a simple series of much longer, stout, round, strongly granulated spines, one to each plate, most of which have enlarged tips. Outside of these the ventral and lateral parts of the rays are openly and coarsely reticulated and bear, on each side, three irregular rows of large, distant spines, those of the first row, near the interambulacral spines, shorter and more numerous than the others, which are separated by distances about equal to their length. All these spines are movable at base, and are round, somewhat tapering, obtuse or rounded at the ends, and covered with closely crowded, coarse, elongated grains, which become longer and more spiniform at the tips of the spines. The dorsal surface of disk and rays is less firm, and more finely reticulated, bearing very numerous, scattered,

small, roughly granulated spines (some of which also occur among the lateral spines), and an imperfect median row of large, distant ones, like those of the sides, but somewhat smaller. The entire surface, between the spines, is covered with coarse, rough granules. Madreporic plate subcentral, small, narrow, elongated, composed of a few radiating lamellæ. Color, in alcohol, reddish brown.

Panama,—F. H. Bradley. One specimen, at low-water of spring tides, on rocks.*

This species is interesting as showing the propriety of retaining Gray's genus *Mithrodia*, which was established to receive *M. spinulosa* (Linck. sp.) and *M. clavigera* (Lamarck sp.). The former is said to be an *Asteracanthion* by Müller and Troschel, and the latter seems to be but little known. For these reasons the necessity of retaining this genus has been doubted by some authors. The present species, however, which agrees well with the characters assigned by Gray, and must be closely allied to *M. clavigera*,† cannot, with propriety, be united to any other genus. It is not at all allied to *Asterias* (*Asteracanthion* M. and Tr.), but approaches more nearly to *Ophidiaster* and allied genera. The ambulacral pores are large and form but two rows.

Heliaster helianthus Gray.

Asterias helianthus Lamarck; Blainville, *Actinologie*, tab. 23, fig. 5.

Asterias (Heliaster) helianthus Gray, *Ann. and Mag. N. H.*, 1st series, vi, p. 180, 1840.

Asteracanthion helianthus Müll. and Tr., *Syst.*, p. 18, 1842.

Numerous specimens of this species, both large and small, were sent from Callao, and a few from Paita, Peru, by Mr. Bradley, a part preserved in alcohol and a part dried. It occurs, also, at Caldera, Chili,—Capt. W. H. A. Putnam (Coll. Essex Institute). It is found on rocks at low-water, adhering very firmly.

Disk broad, rays short, slender, about thirty or thirty-five. Radii as 8:5. A medium-sized specimen measures from center to end of rays 4 inches; to edge of disk 2.5; length of rays beyond disk variable, longest about 1.5.

The interambulacral plates bear a single row of rather long, stout, blunt spines, one to each plate, a large and small one often alternating; outside of these, but near them, the ventral plates bear about

* Two specimens have since been sent from La Paz, by J. Pedersen,—Reprint.

† Another species of this genus, with remarkably long arms, which must be nearly allied to the *M. clavigera*, was collected at the Sandwich Islands by Mr. Horace Mann, and by him presented to the Boston Society of Natural History.

three rows of spines, which are crowded and rather indistinct, decreasing in length outwardly from the ambulacral grooves, those of the first row being of about the same size and shape as the interambulacral. Beyond these on the sides of the rays there are three, more distant, regular, longitudinal rows of short spines, those of the two lowest being conical and somewhat sharp; those of the upper flattened, and blunt, or dilated at the ends. On the dorsal side, each ray has a crowded, irregular, broad, median belt or row, and a more simple, crowded, marginal row on each side, all of which extend to the central area of the disk, where the spines become very numerous and irregularly crowded. All the spines of the upper surface are short and thick, with enlarged, rounded tips. Numerous, very small, short, pointed pedicellariæ are scattered over the surface between the spines, and beneath, among the lateral and ventral spines, there are other much larger ones, which are short, broad-oval, with pointed tips. Madreporic plate small, inconspicuous, irregular.

Color, in life, dark greenish brown, the spines reddish, yellowish, or light green.

Heliaster microbrachia Xantus, Proc. Phil. Acad. Nat. Sci., 1860, p. 568.

A few specimens that appear to be identical with this species were collected by Mr. Bradley at Panama and the Pearl Islands, on rocks at low-water, and in cavities higher up. The original specimens of Mr. Xantus were obtained at Cape St. Lucas.

Disk very broad, rays relatively shorter than in the preceding, small, slender, about thirty in number. Radii about as 3 : 2. A medium-sized specimen measures from center to end of rays 2·8 inches; from center to edge of disk 2; the free part of the rays varies in length from ·5 to 1 inch.

The interambulacral plates bear a single row of slender, blunt spines, which are quite long toward the mouth, but shorter than in preceding species on the free part of the rays; small spines frequently alternate with the larger ones. Outside of these along the lower and lateral sides of the rays there are about four regular longitudinal rows of longer and stouter spines, not clearly distinguishable into ventral and lateral, but those of the upper rows are more flattened and clavate at the ends. The dorsal side of the rays is covered with numerous, small, slender, sub-acute, nearly equal spines, arranged along each margin in a distinct row, which extends inward on the disk, but not forming a distinct median row, the surface between the marginal rows being nearly evenly covered with the spines, among which indications of five or six indistinct rows may, sometimes, be traced. The surface

of the disk is thickly covered with similar spines, irregularly scattered, except toward the outer part, where they have a tendency to form radiating rows continuous with those on the rays. Minor pedicellariæ small, short and thick, thinly scattered among the spines on the disk, but becoming very numerous toward the end of the rays, less so among the lateral and ventral spines. Major pedicellariæ not observed. Madreporic plate rather large, oval.

Color, in alcohol, brownish black above, yellowish below.

This species is closely allied to the preceding, but is quite different in appearance. It may be distinguished by its relatively shorter rays; the much smaller and sharper spines of the upper surface, which are much more numerous and scattered, and do not form three distinct rows on the rays; by the larger and more uniform lateral and ventral spines, which are crowded toward the ambulacral furrows.

Heliaster Cumingii Gray.

In a collection from Zorritos, Peru, Mr. Bradley has sent several specimens of various sizes, which are, perhaps, the species described by Gray. He also collected a few specimens at Paita.

These resemble in form *H. helianthus*, but have exceedingly short rays, ranging in number from 34 to 41. One of the largest specimens measures from the center to end of rays 4.5 inches; to edge of disk 3.8, the rays being mostly about half an inch in length. A smaller one has a greater radius of 3.4 inches; lesser 2.8. The length of the rays varies from one-eighth to less than one-tenth of the entire diameter. The spines of the upper surface, also, are less numerous, and much stouter, with more swollen tips, which are rounded and capitate. They are arranged in a regular, simple, marginal row on each side, and an irregular median series, sometimes forming a regular double row, all the rows extending inward to near the center of the disk, where they become irregularly scattered, but have nearly the same form and size. The interambulacral spines form a single row, one to each plate, and are mostly rather stout, with enlarged, blunt tips. Outside of these, toward the edge of the disk, there is a row of spines of about the same length, but stouter and more clavate, and flattened at the ends. On the sides of the rays there are, in addition, two or three imperfect rows of similar, but shorter and more flattened spines.

Zorritos, and Paita, on rocks, at low-water,—F. H. Bradley.

Under the name of *Asterias (Heliaster) Cumingii* Dr. Gray* very briefly described a species, allied to or identical with this, as follows:

* Annals and Magazine of Natural History, 1st series, vol. vi, p. 180, 1840.

"Arms 30 or 31, very short, not one-tenth as long as the diameter of the body, conical, with blunt spines."

"Inhabits Hood's Island, on rocks at spring tides, H. Cuming, Esq."

Heliaster Kubiniji Xantus, loc. cit., p. 558, 1860.

A good specimen, agreeing well with this species, was presented to us by Mr. Horace Mann, who obtained it, with several other characteristic Panamic species, from Mr. Pease at the Sandwich Islands. It probably came from Acapulco or Mazatlan. Mr. Xantus obtained his original specimens at Cerro Blanco, off Cape St. Lucas.*

Disk relatively smaller than in either of the preceding species; rays twenty-three, longer and rounder, gradually tapering. Radii as 2:1. From center to end of rays 3.2 inches; to edge of disk 1.6.

The interambulacral spines are subequal and blunt, and form a single, close row, one to each plate. Just outside of these there is a row of longer and very stout ventral spines, obtuse and flattened or clavate at the ends. Beyond these there are three lateral rows of much smaller and shorter, tapering, blunt spines, regularly arranged. The dorsal surface of the rays has five regular rows of larger, short, obtuse, and mostly clavate spines, the median row having larger spines than the two on each side, which are regular and equally spaced. All the dorsal rows extend inward to the central area of the disk, where the spines become irregularly scattered, and much larger and stouter, with dilated, truncate, or even concave ends. Minor pedicellariæ very small, ovate, pointed, very numerous on the upper side of the rays near the ends, and among the lateral and ventral spines. Madreporic plate small, very convex, about half an inch from the center.

This species is very different from the two preceding. It is readily distinguished by its fewer, longer, and rounded rays; by the five regular rows of spines on their dorsal surface; by the larger, stout spines of the central part of the disk, often dilated and capitate or concave at the end; by the very stout spines of the first ventral row; and smaller and more equal interambulacral spines.

Dr. Gray has very briefly described, in the work previously cited, under the name of *Asterias (Heliaster) multiradiata*, a species that seems, in some respects, allied to this. His description is as follows: "Arms 22 or 24, cylindrical, elongated, tapering at the ends, one-third longer than the diameter of the body; the dorsal series of spines rather longer and more compressed.

Inhabits Hood's Island,—H. Cuming, Esq."

* Capt. J. Pedersen has recently sent it from La Paz,—Reprint.

Whether the Hood's Island referred to be the one in the Galapago Group, bearing that name, is somewhat uncertain.

In the character of the dorsal spines and the much longer rays, his description differs widely from our specimen.

Stichaster aurantiacus Verrill.

Asterias aurantiacus Meyen, Reise um die Erde, 1834.

Stichaster striatus Müll. and Trosch., Wieg. Arch., vi, B. ii, p. 323, 1840.

Tonia atlantica Gray, Ann. and Mag. Nat. Hist., vi, p. 180, Nov., 1840.

Asteracanthion aurantiacus Müll. and Trosch., System der Asteriden, p. 21, 1842.

Numerous specimens of this species were obtained by Mr. Bradley at Callao, Peru, on rocks at low-water mark. It has also been described from Chili.

Its color in life, according to Mr. Bradley, is bright orange; dried specimens are dull yellow.

The following species, which was omitted in its proper place, on page 272, following *L. tessellata*, is inserted here chiefly on account of the peculiar interest connected with its geographical distribution.

Ludia Bellonæ Lütken, Kritiske Bemærkn., Vidensk. Meddelelser, 1864, p. 133.

Two specimens, apparently identical with this species, were collected at Callao, Peru, by Mr. Bradley. The specimen described by Dr. Lütken was believed to have come from Guayaquil. If this be true, it is the only instance known to me of a species of starfish common to the Peruvian and Panamic faunæ, except *Heliaster Cumingii*, but neither of these have been found at Panama.

Our largest specimen, preserved in alcohol, has a greater radius of 3·7 inches; lesser, ·5. Another dried specimen is about half as large. The five rays are narrow, more convex than usual in this genus, scarcely depressed, the edges not thin. Interambulacral plates bearing three spines (occasionally but two) the inner one slender and shorter than the others, curved, the outer one stoutest, straight, a little longer than the middle one. Ventral plates bearing very small, slender, papillary spines, and a transverse row of about five large blunt ones, increasing in size to the margin, the longest about equal to the outer ones on the interambulacral plates. The paxillæ of the upper surface are unequal in size, the large ones are arranged in transverse rows of about six on each side of the rays, and bear a short, blunt spine in the middle, surrounded by 8 to 12 very small, shorter radiating papillæ. Smaller paxillæ are scattered among these and also occupy the disk and middle of the rays.

Color, in alcohol, yellowish, mottled with dark brown above.

Order, ECHINOIDEA.

In the identification of several species of the following Echini I have been greatly aided by Mr. Alexander Agassiz, of the Museum of Comparative Zoölogy, who kindly compared with me a set of our specimens with the types of species described by himself in the Bulletin of the Museum, and also gave in exchange authentic specimens of several of those species. Without this assistance some of the identifications could not have been made with so much certainty as was desirable.

Cidaris Thouarsii Valenciennes.

Cidaris Thouarsii Agassiz and Desor, Catal. Rais. des Echinides, Ann. des Sci. Nat., vi, p. 326, 1846.

Mr. Bradley has sent numerous specimens of this species from Panama and the Pearl Islands, where it occurs among rocks and in cavities at low-water. It has been described from the Galapago Islands and California (Ag. and Des. Cat. Rais.). The Smithsonian Institution has presented specimens from Cape St. Lucas, collected by J. Xantus.*

This is closely allied to *C. annulata* Gray, common at Aspinwall and the West Indies, but differs in the wider and more closely granulated median area of the interambulacra and in having much stouter and relatively shorter spines, which are more coarsely sculptured on the surface. The large spines are round, largest a short distance above the base, and then slightly and gradually diminish to near the ends, which are enlarged and obtuse. A specimen 1.25 inches in diameter has the large spines 1.3 long, .15 in diameter. The small spines at their bases are flat, thin, spatulate, obtuse at the ends. The ovarian plates form a regular five-rayed star, more distinct than in *C. annulata*. Color of the larger specimens, when dry, deep brown, with the larger spines light purplish brown. Young specimens, in alcohol, have the spines light purple, banded with white.

Diadema Mexicana A. Agassiz, Bulletin Mus. Comp. Zoöl., No. 2, p. 20, 1863.

We have received from the Museum of Comparative Zoölogy, through the kindness of Mr. A. Agassiz, a good example of this species, collected by him at Acapulco. In the Smithsonian Institution there are a few young specimens, apparently of the same species, collected at Cape St. Lucas by J. Xantus.

Our specimen has a test 2.25 inches in diameter, 1.25 high; diame-

* Sent in abundance from La Paz, by J. Pedersen,—Reprint.

ter of the actinal area, not including actinal cuts, 1.10; extreme diameter, including cuts, 1.25; of abactinal area .3; longest spines about 5 inches in length, .07 in diameter.

This species is allied to *D. Antillarum* Phil. of Aspinwall and the West Indies, but may be at once distinguished by its much larger actinal area, as compared to the abactinal area, or to the diameter of the test. In *D. Mexicana* the proportion of the actinal area to the diameter of the test is about 1:2.05, in *D. Antillarum* as 1:2.3. In *D. Mexicana* the large tubercles of the outer interambulacral rows continue nearly to the ovarian plates, diminishing but little in size, and there is less space, also, above the median rows than in the other species.

The sutures between the interambulacral plates are rather deep and well marked. The spines are very long and sharp, about twice as long as the diameter of the test.

Color of the dried specimen brownish black, spines black. Young specimens about half an inch in diameter, from Cape St. Lucas, have the spines regularly banded with deep purple alternating with purplish white.

Echinodiadema, gen. nov.

Test depressed, circular. Actinal cuts slight. Buccal membrane with five principal groups of oblong scales, bearing numerous slender spines and pedicellariæ. Ambulacral pores trigeminate, the poriferous zones wider beneath, where the rows of three pairs are more transverse. Tubercles arranged much as in *Diadema*,—two principal rows in the ambulacra, and four in the interambulacra, of which the external ones are smaller and border the poriferous zones. Anal membrane small, covered with small scales. Spines long, slender, hollow, externally resembling those of *Diadema*.

Echinodiadema coronata Verrill, sp. nov.

Test circular, much depressed, actinal opening one half the diameter of test, with very slight cuts, its membrane partially covered by five principal groups of large oblong scales, which support numerous slender, somewhat clavate spines, .1 inch long, and numerous short, rounded pedicellariæ. Ambulacral pores large, in arcs of three pairs, becoming more oblique below, where the zones are wider; tubercles in two rows, rather large, with a median zigzag line of miliaries. Interambulacra about twice as wide as the ambulacra, with two rows of tubercles, somewhat larger than those of the ambulacra, reaching the abactinal region; external to these are two irregular rows of small tubercles bordering the ambulacra; and between them two imperfect

rows of about the same size, arranged alternately, with smaller miliaries scattered among them. The three uppermost tubercles of both the ambulacral and interambulacral systems are very small, and the two next the last bear very small slender spines with globular, bright purple tips. The ocular and genital plates bear each a somewhat longer, slender spine. Abactinal system small, somewhat angular, depressed, spines twice as long as the diameter of the test, rather stout, with conspicuous verticillations, annulated with narrow bands of purplish brown and light brown.

Diameter of test .85 of an inch; height .35. Cape St. Lucas, Lower Cal.,—J. Xantus. From the Smithsonian Institution.

Astropyga venusta sp. nov.

Test circular, much depressed, nearly flat below, fragile, the ambulacra considerably elevated above the general surface on the upper side. Actinal area about one third the diameter of the test, its membrane covered with unequal scales. Ambulacral zones about one third as wide as interambulacral at the periphery, not varying much in width to the actinal area, but tapering gradually to a point on the upper surface where they are elevated and conspicuous. Pores in arcs of three pairs, which are much more oblique above than below. Ambulacral tubercles alternating in two rows, variable in size, largest on the lower surface. Interambulacral tubercles in eight principal rows, the four median not extending much above the outer curvature of the margin, leaving a naked portion above. The tubercles of the external row are largest but extend only a little further toward the center, with about three tubercles more. The row next to the external has much smaller tubercles and extends to the summit. The naked spaces radiate from the center and soon fork, one branch passing down between the second and third rows of tubercles along each interambulacral border. These spaces are much depressed toward the center and are light purple, with a row of dark purplish spots extending to the end on each side, just within the second row of tubercles, and terminating at the periphery. The color of the lower surface is light yellowish, extending upward in the center of each interambulacrum in a broad petal-like space between the purple forks of the naked area; and in other narrower lobes, embracing the ambulacra and outer interambulacral tubercles, to the ocular plates. Spines very slender and unequal in length, the longest about one half the diameter of the test, finely barbed and longitudinally striated, light flesh-color, or greenish with narrow bright purple bands. Actinal cuts not deep. Diameter 2.3 inches; of actinal area .75; of abactinal area .35; height of test about .75.

A much larger specimen has a test 4.4 inches in diameter, with longest spines 3.5 inches long; anal area .55 in diameter; genital plates .35 in length, .28 in breadth; ambulacra .45 wide at the periphery.

In this specimen the ambulacra are much more elevated above the abactinal area and interambulacra of the upper surface than in the smaller ones. The genital plates are large and acutely triangular, projecting considerably into the interambulacral spaces, forming a well-marked star. The interambulacral zones are over five times as wide as the ambulacral at the periphery, where they have ten or twelve rows of large tubercles, with a few small tubercles irregularly scattered among them. Near the edge of ambulacral zones, on each side, a row of primary tubercles extends upward to the fifth plate from the abactinal area; between this row and the ambulacra there is a row of smaller alternating tubercles extending a little higher; and on the other side another similar row of small tubercles extending as far as the genital plates. The next row of primary tubercles attains only to the periphery; and the third, counting from the ambulacra, terminates two plates below; the fourth extends six plates higher than the third, and considerably beyond the outer arch of the shell; the fifth ceases two plates earlier than the fourth; and the sixth one plate sooner, or scarcely above the outer arch. The median spine-bearing area of the ambulacra has, therefore, a broad petal-like form on the upper surface, reaching about midway to the abactinal area and considerably beyond the fourth row of primary tubercles, its upper portion including only small scattered tubercles. Its outline is well defined, owing to the contrast between the light yellow color of this area, and the deep purplish brown of the naked space above and on each side of its upper portion. The ambulacral tubercles are unequal in size and form two irregular rows.

The color is nearly like that of the first specimen described, but somewhat darker. The spines of the upper surface are greenish, banded with purple; below, yellowish or reddish white with few purple bands, or quite plain.

Two specimens in alcohol, intermediate in size between those above described, agree well with the characters indicated. The buccal membrane bears a few very small and slender spines, scattered over the surface and more numerous near the mouth. The spines of the lower surface are all small, slender, rarely exceeding an inch in length, the largest ones enlarged and flattened near the ends, mostly light yellow in color, with faint bands of purple. The long spines are greenish at the base and have narrow bands of bright purple; the

short spines of the upper surface are light green, with narrow purple bands.

In life, according to Mr. Bradley's observations, the spots along each side of the interambulacral zones are bright blue and very conspicuous.

Panama and Pearl Islands;* one specimen was found on the reef at low-water, the others were dredged in four or five fathoms, on shelly bottom,—F. H. Bradley.

This species has probably been confounded, hitherto, with *A. radiata* of the Indian Ocean, at Zanzibar, etc., to which it is closely allied.

Echinocidaris stellata (Blainv. sp.) Agassiz and Des., Catal. Rais., 1846.

Echinocidaris incisa A. Agassiz, Bulletin Mus. Comp. Zoölogy, No. 2, p. 20, 1863.

Echinocidaris longispina Lutken, Bidrag til Kundskab om Echiniderne, p. 62, Vidensk. Meddelelser, p. 130, 1864.

A large number of specimens of this species, of various sizes, were collected by Mr. Bradley at Panama and the Pearl Islands, where they occur at low-water mark on the reef, among stones and in crevices. At Zorritos, Peru, he obtained many specimens of large size, and, also, a few from La Union, San Salvador. From the Essex Institute we have a specimen from Margarita Bay, Lower California. It also occurs at the Galapago Islands (Agassiz and Desor), and at Guayamas (A. Agassiz), and Realejo (Dr. Lütken). Mr. Bradley obtained one living specimen at Paita, Peru.

The specimens described by Mr. A. Agassiz were not fully grown, and differ in some respects from larger ones.

A specimen from Zorritos, measuring six inches in diameter, including the spines, has spines two inches in length; others have somewhat shorter spines. The spines near the center of the upper surface are quite short, but increase rapidly in length toward the periphery, where they are longest, round, moderately slender, gradually tapering. On the lower side they diminish rapidly in size and length and have flattened tips; around the actinal area they are quite small.

A specimen having the test 2.1 inches in diameter, and 1.35 high, has the actinal opening 1 inch in diameter; the anal area .3; from the outside of an ocular plate to the outer point of the opposite genital plate .6; length of genital plates .22; greatest width .2; breadth of ambulacral zones at periphery .42; of interambulacra .85. Test usually regularly arched above, often a little depressed.

The genital plates are large, pointed outwardly, and project into the interambulacra so as to form a very distinct star; inwardly their

* More recently sent by J. Pedersen from the Gulf of California, near La Paz,—Reprint.

sides unite together for a short distance so that the ocular plates do not join the anal area; the madreporic plate is much larger than the others. The anal area is broad-oval, its four plates usually prominent. The ambulacral zones are, ordinarily, somewhat elevated and in some cases considerably so, giving a somewhat pentagonal form to the outline of the test. They bear two regular rows of tubercles, nearly as large as the interambulacral beneath and on the sides, but becoming very small above and disappearing before reaching the summit. Interambulacra with large naked median spaces, extending about half-way to the periphery; sutures between the plates rather deep and conspicuous. The plates are very broad, fifteen forming each vertical series in the specimen above measured. The tubercles are very large on the sides, forming six vertical rows, which are not crowded. The two middle rows are represented at the periphery by a few tubercles only; the two next extend from the actinal area to within about five plates of the summit; the outer row on each side continues even to the ocular plates, but the two or three upper tubercles are much smaller than the lateral. Actinal area sub-pentagonal, the cuts shallow. Auricles short and broad, the supports widely separated at the ends.

Color of test, in dried specimens, grayish or purplish brown, weathering to purplish white or rose-color; the lower half or the whole of the outer end of the interambulacral plates deep purple, in the naked spaces of the upper surface, forming a double series of conspicuous, alternating, angular spots; genital plates variegated with purple; spines dark purple.

A specimen 1.35 inches in diameter of test has but eleven interambulacral plates in the vertical series and but four rows of large interambulacral tubercles, with a very few belonging to a fifth row. In this the auricular supports are short, broad at the ends, where they are in contact or overlap.

Specimens .4 in diameter have but eight plates in the vertical series. The outer row of interambulacral tubercles reach the summit, but the intervening rows are represented only by three or four irregularly placed tubercles on the lower surface. The spines are mostly flattened and channeled at the ends, the longest equaling the diameter of the test. Sutures more marked than in the large examples.

An examination of a large number of specimens of all ages and from various localities has convinced me that the *E. stellata* of Agassiz is the same as *E. incisa* A. Ag. Dr. Lütken's work was printed before he had received that of Mr. Agassiz. He has suggested that his species might prove identical with *E. stellata*.

Echinocidaris spatuligera Agassiz, Catal. Rais., 1846.*

Echinus spatuliger Val., Voyage Vénus, Zoöl., pl. 5, fig. 2, 1846.

Numerous specimens of this species were found by Mr. Bradley both at Callao and Paita, Peru, thrown upon the shore after storms. It has been recorded from Coquimbo (Catal. Rais.), and from North Chili (Philippi).

A specimen of the usual size has a diameter of 2·1, not including spines; height 1·3; longest spines 1·8; diameter of actinal area ·98; of anal area ·28; from the outside of an ocular plate to the outer end of the opposite genital plate ·48; length of genital plates ·13; width ·15. Test with a regularly rounded outline, often subconical, sometimes regularly arched above, usually less depressed than the preceding species.

The genital plates are rather small, with an obtuse angle outwardly, the adjacent ones usually separated completely by the ocular plates, which reach the anal area, except the two next to the madreporic plate. The ambulacral zones have two close rows of tubercles, which become very small on the upper surface and do not reach the summit. The interambulacral plates are narrower and more numerous than in the preceding species, 18 forming a vertical series: those near the outer parts and beneath, except near the actinal opening, bear four tubercles, forming obliquely transverse rows on the plates and eight vertical rows in each interambulacral zone, of which the two middle rows are irregular and consist of smaller tubercles. The primary tubercles, below and on the sides, are crowded, subequal, of moderate size. The row next the ambulacra reaches the ocular plates, the upper tubercles, like those of all the other rows, being very small; the next row ceases at the fourth plate from the summit; the third, two plates sooner; the fourth, two or three plates sooner than the third. The median naked spaces of the upper side are, therefore, narrow and less distinctly bounded than in *E. stellata*, owing to the smallness of the surrounding tubercles.

The color of dried specimens is dark reddish brown, much lighter beneath; spines reddish or purplish brown. Young specimens have purplish poriferous zones, and grayish brown interambulacral spaces.

A specimen ·9 of an inch in diameter has five rows of interambulacral tubercles with rudiments of a sixth. The outer rows reach the summit, but the next cease at the sixth plate from it.

A young specimen, ·5 in diameter, has but four rows of interambulacral tubercles, the two outer rows reaching the summit, the others scarcely extending above the outer curvature of the sides.

* A recent examination of this species confirms its identity with that of Valenciennes, but the latter differs in its flatter spines, which in ours is variable.—Reprint.

This species is readily distinguished from *E. stellata* by much more numerous, more crowded, and smaller interambulacral tubercles; by the narrower and more numerous plates; by the much smaller genital plates, which are outwardly obtuse instead of acute, so that they do not form a well marked star, and are broader than long, while in *E. stellata* they are longer than broad. The lateral union of the genital plates in front of the ocular plates is a good distinctive character for the latter species, as well as the greater size of the abactinal star; deeper sutures between the plates; and the variegation of the test.

This species in some respects corresponds with *E. Davisii* A. Ag., found from Long Island Sound to Virginia, while *E. stellata* may be considered the Pacific representative of *E. punctulata* of the Carolina coast and Florida.

Arbacia nigra Gray.

Echinus niger Molina, Hist. Nat. du Chili, p. 175.

Echinus purpureus Val., Voy. Vénus, pl. 5, fig. 1, 1846.

? *Echinus grandinosus* Val., op. cit., pl. 11, fig. 1.

Echinocidaris (Tetrapygos) nigra Agassiz, Catal. Rais., 1846.

This species was found at Callao, Peru, in great abundance by Mr. Bradley, thrown upon the beaches, and also living at low-water mark among rocks. It has been recorded from Paita, (Ag. and Desor).

The Essex Institute has specimens collected at Caldera, Chili, by Capt. W. H. A. Putnam, who also collected it at Mejillones.

Psammecinus pictus Verrill, sp. nov.*

A small species with a regularly rounded profile, somewhat hemispherical in form, but slightly depressed. Spines slender, moderately long, one fourth the diameter of the test. Actinal region large, nearly one half the diameter of the test, its membrane covered with small irregular scales. Ambulacral zones about two thirds as broad as interambulacral. Pores in regular arcs of three pairs, which become much narrower beneath. Ambulacral tubercles in four series, those of the two exterior relatively large and prominent, not crowded; between these the miliaries form two somewhat irregular rows. In the poriferous zones a small tubercle separates the successive arcs, forming a regular row of distant tubercles, not larger than the largest miliaries. Interambulacral spaces with two principal rows of tubercles, near the exterior, about the same size as the principal ones of the ambulacra. Exterior to these are two outer rows of much smaller tubercles that do not reach the summit; in the space between the two principal rows similar secondary tubercles are distantly scattered; miliaries numerous around the larger tubercles. Ocular and genital

* Mr. A. Agassiz thinks this the young of *Lytechinus semituberculatus* V.,—Reprint.

plates each with a group of small, unequal tubercles. Abactinal area small, closed by five principal plates of unequal size.

Color of spines, on a specimen dried from alcohol, bright purple, test light purple with yellowish white bands extending from the actinal area along the poriferous zones and covering the adjacent tubercles as far as the outer curvature of the sides, forming thus a ten-rayed star. An undefined space around the ocular and genital plates is also yellowish white. A narrow black ring surrounds the teeth. Diameter of the largest specimens about one inch.

Cape St. Lucas, Cal.,—J. Xantus, (Smithsonian Institution).

Lytechinus A. Agassiz, Bulletin Mus. Comp. Zool., p. 24, 1863.

Hemiechinus (pars) Girard, MS. (Coll. Smithsonian Inst.).

Psilechinus Lütken, Bidrag til Kunskab om Echin., p. 25, 1864.

This genus agrees with *Psammechinus* in having the pores in oblique rows of three pairs, and in the scales of the buccal membrane, but differs in having deeper actinal cuts, with thickened, or sometimes revolute, edges; and in having partially naked median spaces on the upper part of the ambulacral and interambulacral zones. The species also attain a much greater size than is usual in *Psammechinus*.

The *Echinus variegatus* may be regarded as the type. In the Smithsonian Institution there are specimens of *L. Carolinus* Ag. under the name of *Hemiechinus nobilis* Girard MS., but I cannot find that such a genus has ever been published.

Lytechinus roseus Verrill,

Boletia rosea A. Agassiz, op. cit., p. 24.

Numerous large specimens of this fine species were dredged in Panama Bay, in 6 to 8 fathoms, shelly bottom, by Mr. Bradley. Mr. Agassiz described specimens from Acapulco.

The largest specimen has a test 3.6 inches in diameter; 1.8 high; diameter of actinal opening, not including cuts, 1.25; depth of cuts .27; from outside of madreporic plate to outer edge of opposite ocular plate .52; diameter of anal membrane .2; length of longest spines .5.

Test thin, fragile, low, subconical, lower side concave, outline somewhat pentagonal. The ambulacral zones are two thirds as wide as the interambulacral, and slightly raised above them, with a narrow, somewhat sunken, median naked space on the upper side. On the lower side there are six rows of ambulacral tubercles, which diminish in size upward, the outside rows attaining the summit, the others ceasing successively sooner. Interambulacral tubercles on the lower side in ten rows, subequal in size; the third row from each margin

alone extending to the summit; the outside one hardly reaching the upper surface; the second reaching about half way from the outer curvature to the genital plates; the inner rows successively shorter than the third. The tubercles in all the rows diminish rapidly on the upper side, those of the third row less so than others; naked median space narrow, depressed, sutures conspicuous.

Genital plates large, the outer end subacute, projecting into the interambulacral spaces. Ocular plates tridentate on the outer side, usually only two of them touching the anal membrane. The anal area is covered with irregular, unequal plates. The poriferous zones are rather broad, the pores large, in oblique rows of three pairs, which become more nearly transverse at the outer margin. Actinal cuts very deep, with elevated callous margins, which, on the side next the interambulacra, are elevated and sharp, slightly revolute, and bounded externally by a shallow groove. The spines are short and stout, on the lower side numerous, blunt, and subequal; on the upper side shorter, more unequal, and not so numerous. The major pedicellariæ in this species are numerous, especially among the spines of the lower side, and are remarkable for their great size, the heads often .13 long; and 6.0 broad at base; with a pedicel .3 or more long. The three branches are slender, somewhat smaller just above the enlarged base. Other short, thick, rounded, and very much smaller pedicellariæ are scattered among the spines, and there is a thick wreath of similar ones around the mouth. The buccal membrane is covered with numerous scattered scales, which become smaller and crowded, near the mouth.

Color, in life, light purple or rose-color; when dried or in alcohol dull purplish white, the test sometimes dull greenish above.

This species, which appears to be beyond question a true *Lytechinus*,* is allied to *L. variegatus* of the West Indies, but still more so to *L. Atlanticus* A. Ag. of Bermuda. The latter differs, however, in having very slender and longer spines, much smaller and more slender pedicellariæ, more uniform tubercles on the upper side, narrower poriferous zones, shallower actinal cuts, a more elevated form, and deep purple color. The specimens of this species were identified by Mr. Agassiz as the *Boletia rosea* by direct comparison with his original specimens. A comparison with the *Psammechinus semituberculatus* will, however, be necessary before it can be definitely ascertained whether they be really distinct.

* By more recent comparisons I have been led to consider it nearer *Boletia pileolus* than here indicated. It is very near, if not identical with *B. depressus*, figured in Voy. Vénus, Pl. 3, fig. 7,—Reprint.

Boletia viridis Verrill, sp. nov.*

A single specimen of this species was obtained by Mr. Bradley at Callao, Peru.

Diameter of test 2·7 inches; height 1·3; diameter of actinal area ·8; from outer end of madreporic plate to outside of opposite ocular plate ·38; diameter of anal area ·18; length of longest spines ·65.

The test is rather thick, depressed above, sides regularly arched, lower side concave, nearly circular in outline. The ambulacra have two rows of primary tubercles extending to the summit, with an irregular row of much smaller ones between them. The interambulacral zones have about six principal rows of tubercles on the lower side, of which the next to the outermost are much the largest on the upper side, and reach the genital plates; the outermost rows have small unequal tubercles. The secondary and large miliary tubercles are numerous on the central part of the interambulacra. The poriferous zones are rather wide, a little narrower beneath. The pores form a nearly regular vertical row on the inner side of the zones, separated from the others by a vertical row of small tubercles, outside of which the pores are rather irregularly placed, but apparently form two irregular alternating, vertical rows. The genital plates bear spines; they have a rounded angle outwardly, and are longer than broad; the openings are large. The ocular plates are small, most of them excluded from the anal area. Anal membrane covered by numerous, angular plates, which bear small spines. Spines short, stout, tapering, very unequal in size. Actinal cuts moderately deep; buccal membrane thin, with a few small widely separated scales. Color of spines bright green, the smaller ones often with light yellow tips; test brown.

Euryechinus Verrill, Proc. Boston Soc. Nat. Hist., x, p. 341.

Echinus (pars) Lamark; Agassiz, Monog. d'Echinod., 2^{me} liv. (Introduction), July, 1841, and liv. 4^{me} (Introduction), Dec., 1841.

Toxopneustes (sub-genus, *pars*) Agassiz and Desor, Catal. Rais., 1846.

This name was proposed, in the work cited, for a group of *Echini* having *E. Dröbachiensis* as the type, and including, in addition, *E. granulatus* of New England, *E. lividus* of Europe, *E. gibbosus*, Galapago Is., and *E. Delalandii* of New Holland. Since that time, however, I have received an authentic specimen of the last species and have satisfied myself that it does not belong to the same group,

* Mr. A. Agassiz considers this the *Echinus chloroticus* Val. If so the specimen described was probably from the New Zealand collection of Mr. Edwards, and accidentally misplaced in packing at Callao,—Reprint.

but rather to the genus, *Toxocidaris* of A. Agassiz, where he had already placed it.

The reasons for not adopting the name, *Toxopneustes*, for this group, are these :

1st. When this name was *first proposed* "*Echinus pileolus*" was mentioned, without description or reference, as its type, (Monog. Ech., 2^{me} liv., p. 7).

2nd. When next mentioned and *first described*, *Echinus tuberculatus* Lamarek was given as its type, and the description applies to such species as are now named *Toxocidaris* by A. Agassiz, (Monog. Ech., 4^{me} liv., p. ix).

3rd. In the work last named the typical species of *Euryechinus* were described under *Echinus proper*, as restricted by the removal of *Tripneustes*, *Toxopneustes*, etc., and therefore were evidently not regarded as belonging to the latter genus.

4th. In a work published five years later (Catal. Rais.) *Toxopneustes* was placed as a sub-genus of *Echinus*, and a variety of forms were referred to it, amounting to thirteen nominal species, among which are several types now regarded as generically distinct. Of these species the 1st, 2nd, and 4th are now placed in the genus *Sphærechinus* Desor; the 3rd, 5th, 7th, and 10th belong to *Euryechinus*; while the 8th (*T. Delalandii*) and 9th (*E. tuberculatus*) are true *Toxopneustes*, now referred to *Toxocidaris* by A. Agassiz; the 6th, 11th, 12th, and 13th are doubtful species, the last fossil.

It is, therefore, evident that if *Toxopneustes* be taken in its original sense, *when first described*, it must be restricted to that group having *T. tuberculatus* as its type, a group apparently equivalent to *Toxocidaris* A. Agassiz, which is represented by several East Indian and Pacific Ocean species, as well as by two species upon the Pacific coast of N. America (*T. mexicana* and *T. franciscana*). These species have the characters originally assigned to *Toxopneustes* in an eminent degree, while to *E. pileolus*, as now understood, neither the name nor description would apply. Therefore there seems to be grave objections against restricting it to the latter species, and its allies, even were it certain that the species now known as *Boletia pileolus*, was the one referred to as *Echinus pileolus*, without authority.

Euryechinus imbecillis Verrill.

? *Echinus gibbosus* Val. MS.; ? *Echinus* (*Toxopneustes*) *gibbosus* Agassiz, Catal. Rais.

Euryechinus gibbosus Verrill, Proc. Boston Soc. Nat. Hist., x, p. 341, 1866.

This species was found thrown upon the beach abundantly at Cal-lao and Paita, Peru, by Mr. Bradley. At the latter locality living

specimens were obtained at low-water. *E. gibbosus* was originally described from the Galapago Islands.

The larger specimens have a test about 2 inches in diameter, and 1 in height; spines .9 long; diameter of actinal area .7; of abactinal area, including genital plates, .6.

The form is rather depressed, the abactinal area somewhat sunken, the sides regularly arched, the lower surface nearly flat. The test is rather thin. The actinal area is small, with slight cuts. The ambulacral zones are nearly as broad as the interambulacral, and slightly elevated above them. The poriferous zones are broad, becoming a little wider beneath; the pores, arranged in oblique, slightly curved rows of four or five pairs above, form on the lower surface more transverse and nearly straight rows of four pairs, with rows of very small tubercles intervening. The ambulacra have two rows of primary tubercles, with an irregular median row of small tubercles between them. The interambulacra have two primary rows of somewhat larger tubercles, midway between the sides and median line, and a row of smaller ones, on each side, bordering the poriferous zones, and a median double row of alternating tubercles of still smaller size. The genital plates are small, broader than long, uniting so as to separate the small ocular plates from the anal area. Madreporic plate small, transversely oval. Spines not very numerous, long, slender, with fine longitudinal striations, the ribs crossed by fine lines. Color, in alcohol, dark purplish brown, when dry test often variegated with light green and whitish; spines dark green, often tipped with purple.

Nearly every specimen examined is irregular in the form of the shell above, near the abactinal area, which is, also, generally distorted or enlarged on one side, where the shell is thinner. This distortion, which often amounts to gibbosity, is irregular and inconstant, and is caused by a parasitic crustacean (*Fabia Chilensis* Dana) allied to the *Pinnotheres*, which inhabit oysters and other bivalve mollusca. This curious parasite* appears to force an entrance into the anal orifice when quite small, and, having effected a permanent lodgment there, causes a dilation and malformation of the intestine, which eventually forms a large membranous cyst or sac, often in the larger specimens extending from the summit to the lower side of the shell, along one side, to which it is attached by fibrous tissues. In one instance the cyst was an inch in length and nearly half an inch in diameter, enclosing a female crab of corresponding size, with large numbers of eggs attached to its abdominal appendages. A large opening is

* *Pinnaxodes hirtipes* Heller, appears to be the same species.

always maintained externally, out of which the claws of the crab may be thrust, but is apparently not large enough to allow it to go entirely out, when fully grown. By this parasite the anal area is so distorted and displaced that among ninety specimens I have not found one in which it is in its natural state, every specimen giving evidence, by distortion or otherwise, of having been infested by it. But as most of these were found dead upon the beach it is probable that they were individuals that had been killed or weakened by the parasite, while specimens unattacked by them may be found in deeper water.

It is probable that the irregularity or gibbosity of the *Echinus gibbosus* Val. was caused by the same or a similar parasite, but whether that name applies to the present species of *Euryechinus* I am unable to determine, the description being too imperfect for reliable identification. But should it prove to be the same, the name is inapplicable, referring only to an accidental, or diseased condition, which is not constant even in the diseased specimens. For these reasons I have thought it necessary to apply a new name to the present species.

The original description of *E. gibbosus* is as follows: * "Espèce irrégulière voisine de l'*E. lividus* par les détails de son test. Quatre paires de pores légèrement arquées. Des îles Gallapagos,—Mus., Paris."

The *Euryechinus imbecillis* can scarcely be said to be near *E. lividus* in the character of the test, since in the latter there are eight or ten rows of subequal interambulacral tubercles, which are larger and far more numerous than in this species, besides many other differences. It approaches much more nearly, in the character of its test and arrangement of its tubercles, *E. Dröbachiensis* and, especially, *E. granulatus* Verrill, of the coast of New England, but is quite distinct from all, in the thinness of its test; in its smaller and weaker genital and ocular plates, and larger size of the anal area and, consequently, of its abactinal system; in the flatness of the lower surface and somewhat widened poriferous zones; fewer tubercles; and more slender spines.

Toxopneustes sp.

Toxocidaris mexicana A. Ag., Bulletin M. C. Z., p. 22, 1863, (no description).

Mr. Agassiz has identified a specimen from Acapulco, in the Museum of Comparative Zoölogy, as the *Heliocidaris Mexicana* Ag. The latter species was originally described (Catal. Rais.) as coming from Vera Cruz. Dr. Lütken refers it to *Echinometra*. In our col-

* Agassiz and Desor, Catal. Rais., in Ann. des Sci., vi, p. 367, 1846.

lection there are two specimens,* received from the Boston Soc. Nat. Hist., and collected by different persons, labeled "Gulf of Mexico?" which I have considered the *Heliocidaris Mexicana* Agassiz. But these belong to the genus *Anthocidaris* of Lütken. Should this identification prove correct, the name, *Anthocidaris mexicana*, may be applied to this species, while the species from Acapulco, since it apparently belongs to a distinct genus, might be allowed to retain the same specific name, but until described this name can only be considered as provisional, and not entitled to priority. For these reasons I leave this species without a name, for the present.

Echinometra rupicola A. Agassiz, Bulletin M. C. Z., p. 21, 1863.

Mr. Bradley sent numerous examples of this species from Panama and the Pearl Islands, where it occurs on the reefs at low-water mark, and in rocky pools. It has the habit of forming excavations in the rocks in the same manner as *Euryechinus lividus* of Europe, most of the larger specimens occurring in such cavities. He also obtained specimens at La Union, San Salvador, and Zorritos, Peru. From the latter locality the specimens are very large and beautiful.

Our largest specimen measures, in the greater diameter of its test, 3.2 inches; smaller diameter 2.8; height 1.5; diameter of actinal opening 1.1; of abactinal area, including genital plates, .45. The spines are variable in length; usually the longest, in large specimens, are from 1 to 1.5 inches long. In a specimen having the test 1.5 inches in diameter some of the spines are 1.6 long.

The test is broad oval, or subcircular, depressed above, regularly arched on the sides, rather flat beneath. Actinal cuts deep and narrow. Interambulacral zones are a third wider than the ambulacral, with at least six rows of large tubercles, those in the next to the outer one largest, continuing to the genital plates. Ambulacra with four rows of smaller tubercles, those of the two median rows largest and regularly arranged, about equal in size to those in the outer row of the interambulacra. In the largest specimen there are 24 ambulacral, and 18 interambulacral tubercles in the principal rows. Poriferous zones rather wide, with seven or eight pairs of pores in well curved arcs. The upper pair in each arc is between the outer and median rows of ambulacral tubercles. Genital plates of moderate size, outward edge acutely angular, openings large; ocular plates reaching the anal area. Spines slender for this genus, regularly tapering to the acute ends, more equal in size than usual, the second series being less numerous. Color dark purple throughout.

* Mr. A. Agassiz considers these, *Echinometra plana* A. Ag.,—Reprint.

Echinometra Van Brunti A. Agassiz, op. cit., p. 21.

Several large specimens of this species, collected at Cape St. Lucas by J. Xantus, have been presented by the Smithsonian Institution. The examples originally described were from Acapulco.

The largest specimen has a test 2 inches across the longest diameter; 1.7 wide; .8 high; actinal opening .85 in diameter; longest spines, which are somewhat broken at the end, 1.6.

In the form of the test this species resembles the preceding, but it is often even more depressed. The interambulacra, in a specimen 1.6 inches in diameter, have two rows of large primary tubercles, with a row of much smaller ones outside of them on each side, bordering the ambulacra, and two imperfect median rows of similar secondary tubercles. The ambulacra have two rows of tubercles, which are smaller than the principal tubercles of the interambulacra. The poriferous zones are very narrow on the upper surface, having nearly vertical arcs of about seven pairs of pores; on the lower side the arcs become more nearly transverse, and the zones are much wider. The genital plates are less acute outwardly, and less prominent than in the preceding species. The spines are large and strong, and when perfect taper to a sharp point. They seldom equal in length the greatest diameter of the test. Color, dried from alcohol, deep ashen brown, or purplish.

This species may be easily distinguished from *El. rupicola* by the fewer and larger interambulacral tubercles; stouter spines; and the very narrow poriferous zones above, with their rapid dilation beneath.

Encope occidentalis Verrill.

Encope tetrapora Agassiz, Monog. d'Ech., Scutelles, p. 49, Tab. 10^a, figs. 1-3, 1841. (non Gmelin).

Plate X, figures 4, 4^a.

Numerous specimens of this species are in our museum, which were dredged in the Bay of Panama in 5 to 8 fathoms, shelly bottom, by Mr. Bradley. He also obtained one large specimen at Zorritos, Peru. The specimen described by Prof. Agassiz came from the Galapago Islands.

The largest specimen is 5.5 inches long; with the extreme breadth 5.7; height .6; from center to anterior opening 1.9; to anterior-lateral 1.8; to posterior-lateral 2; to posterior 1.5; from center to anterior margin 2.6; to posterior margin 2.9; from center to end of anterior ambulacral rays 1.7; of lateral 1.5; of posterior 1.72; breadth of anterior ray .67; its median region .3; breadth of lateral .7; its middle .35; breadth of one of the posterior pair .7; the middle area .3; length of posterior foramen .5; center of mouth to anus .65.

Test much depressed, becoming gradually very flat toward the margin; highest part at the middle of the anterior ambulaerum. Margin broadly rounded posteriorly, the widest place opposite the middle of the posterior ambulaera; sides wavy, converging somewhat toward the anterior side, which is slightly emarginate in the middle. The posterior opening is rather oblong, relatively nearer to the center than in most species; the other openings are elliptical, the anterior one shortest. The rays are broad, shorter than usual, especially the antero-lateral pair. The genital openings are large, and form a regular pentagon. The anal opening is situated about midway between the mouth and posterior foramen. The sulcations of the lower surface are very distinct and much branched.

Color deep reddish brown, or dark greenish brown.

This species can readily be distinguished from *E. emarginata*, and its varieties, and *E. Michelini* of the West Indies, by its broader form, narrowing anteriorly; by the relatively broader and more equal, ambulaera; and by the position of the posterior foramen, it being half its length nearer the center than the postero-lateral ones.

Dr. Lütken, apparently with good reason, refers the *Echinus tetrapora* Gmelin to the *E. emarginata* of the West Indies. Our species appears to be the one well figured and described by Prof. Agassiz under the former name, and will, therefore, require a new designation.

The specimen figured by Agassiz is smaller than any of ours, and had the postero-lateral lunules still open, while in all the specimens that I have seen they are completely closed, unless opened by reason of some injury.

Encope grandis Agassiz, op. cit., p. 37, Tab. 6.

Two specimens, apparently belonging to this species, are in our collection, one of which, received from the Boston Society of Natural History, is labeled as coming from the Gulf of California, and the other, presented by Mr. Horace Mann, was obtained by him from Mr. Pease, with several other characteristic Panamic and Californian Echinoderms, but without any authentic locality.*

The latter agrees perfectly with the figure and description by Agassiz. The origin of his specimen is unknown, but it was supposed to have come from the Antilles. Owing to lack of perfectly authentic localities, I prefer to avoid confusion and possible error by omitting descriptions until more authentic specimens can be obtained.

* Several dozens of large and fine specimens have recently been sent from La Paz by J. Pedersen.—Reprint.

Astriclypeus Verrill, gen. nov.

Ambulacral star as in *Encope*; four genital openings, the posterior one wanting, as in *Mellita*; with five lunules or perforations in the prolongations of the ambulacra, as in *Encope*; but destitute of any perforation or indentation in the posterior interambulacrum, like *Lobophora*. Anal opening round, about midway between the mouth and margin. Sulcations of the lower side more simple than in *Encope*, a primary branch passing along close to the openings, on each side, and sending off numerous inconspicuous branches to the interambulacra. Actinal opening as in *Encope*.

This genus presents a remarkable combination of characters belonging to other allied genera, but has an assemblage of characters entirely unique. It appears to be most nearly allied to *Lobophora*, from which it differs chiefly in possessing five ambulacral lunules or openings, instead of but two; and in the sulcations of the lower surface.

Astriclypeus Mannii Verrill, sp. nov.*

Test subcircular, about as long as broad, with the posterior side slightly truncate, and a slight prominence of the edge opposite each opening. Summit central, considerably elevated.

Length 4.2; breadth the same; height .65; from center to anterior opening 1.2; to the lateral ones 1.1; to end of anterior ambulacral ray 1.2; to lateral .98; breadth of anterior ambulacral ray .42; of its median area .16; of the anterior lateral .45; its median area .2; length of three anterior openings .6; breadth .18; length of posterior openings .7; breadth .18; center of mouth to anal opening 1 inch; from the latter to the margin the same.

The anterior ray of the ambulacral rosette is a little longer and narrower than the others, with the widest part near the end, which is not closed; lateral rays nearly equal in length, the anterior pair a little wider, increasing in width to near the end, which is broad and rounded. Openings oblong, the posterior pair a little longer. Anal opening nearly circular, midway between the mouth and margin.

Locality West Coast of North America (?). (Japan,—Reprint).

The single specimen of this curious species was presented by Mr. Horace Mann, of Cambridge, Mass., in honor of whom I have named it. It was obtained by him, with several other West Coast Echino-

* Dr. F. H. Troschel has well described and figured this species under the name of *Crustulum gratulans* in Niederrh. Gesells. für Naturg. und Heilkunde, Universität Bonn, Aug. 3, 1868, p. 1, Pl. I. In Archiv für Naturg. 1869, p. 52, he has identified it with our species and described specimens from Japan (E. von Martens),—Reprint.

derms,* from Mr. Pease of the Sandwich Islands. Its origin is entirely doubtful. It is destitute of spines and in the same state of preservation as a *Dendraster excentricus*, which came with it.

Echinoglycus Stokesii Gray; A. Ag., Bulletin M. C. Z., p. 26, 1863.

Encope Stokesii Agassiz, Mon. Scutelles, p. 59, Tab. 6a, figs. 1 to 8, 1841; Lütken, Bidrag til Kundskab. om Echin., p. 65, 1864.

This species was found abundant on a sandy beach near Panama, at low-water mark. Dr. Lütken's specimens were from Punta Arenas, whence he has sent examples to us. It has also been described from Guayaquil and the Galapago Islands.

The larger specimens from Panama are two inches long; 2·15 broad; ·25 high at center; from center to end of anterior ambulacral ray ·55; to end of anterior-lateral ·5; posterior-lateral ·48; center to genital openings ·08; width of anterior ambulacral ray ·25; its central area ·11; width of the four lateral rays ·27; central area ·11; center to anterior lunule ·8; to anterior-lateral ·73; to posterior-lateral ·67; to posterior perforation ·68; its length ·2; breadth ·1; mouth to anal opening ·42. The form is nearly circular, the posterior interambulacrum usually slightly truncated. Lower surface flat, upper side most elevated at the center of the rosette, which is behind the middle; test rather thin and brittle. Six lunules or perforations, the posterior one, even in very young specimens, is a rounded oblong perforation, in the adult specimens becoming twice as long as wide; the lateral ones appear at first as shallow notches in the edge, which gradually become narrow, long or oval, and in the larger specimens all, except the anterior one, become closed at the edge. In young specimens the posterior-lateral notches appear first, the anterior one not being apparent in a specimen ·6 of an inch in diameter; in the larger specimens its outer edges are in contact and doubtless finally unite. Ambulacral rays short and broad, a little elevated above the general surface; the anterior odd one longer and narrower than the others; posterior pair shortest, but about equal in width to the anterior pair; along the middle of each there is a narrow naked line. Genital openings usually five, large and regular, sometimes the posterior one is double or irregular. Spines of the upper surface crowded, uniform, very slender, enlarged or clavate at the tips; the edge fringed with larger and

* The species received in this collection are as follows: *Linckia unifascialis* Gray, *Nidorellia armata* Gray, *Oreaster occidentalis* Verrill, *Heliaster Kubiniji* Xant., *Culcita*, sp., *Dendraster excentricus* Ag., *Encope grandis* Ag., *E. occidentalis* V., *Astriclypeus Mannii* V.

longer ones, not clavate; lower surface with three kinds, the median region of each interambulaerum with crowded spines, which are longer and stouter than those of other parts and slightly enlarged toward the ends; on the median area of the ambulaera, in line with the lunules, the spines are similar in form, but much fewer and smaller; between these two kinds the surface is covered with very small crowded, clavate spines, similar to those of the upper surface, but less enlarged at the tips. Color, when dried, dull greenish brown.

Mellita Pacifica Verrill, sp. nov.

A depressed, subeircular species, with six perforations; allied to *M. hexapora*, but having a large, round posterior, and small, narrow ambulaeral perforations; spines of the upper side short and crowded.

Length, not including spines, 2.2 inches; greatest breadth 2.3; height .25; from center to end of anterior ambulaeral ray .58; to end of anterior-lateral .55; of posterior-lateral .61; width of anterior ambulaeral ray .27; its central area .13; of anterior-lateral .25; its central area .12; of posterior lateral .25; its central area .10; from center to anterior perforation .83; to anterior-lateral .81; to posterior-lateral .8; to posterior .4; length of latter .25; its width .2; mouth to anal opening .25; length of marginal spines .15.

The outline is nearly circular; broadest a little behind the center, where the outer edges of the posterior-lateral interambulaera are somewhat prominent beyond the rest of the outline; center of abactinal rosette a little behind the middle; edges thin. The five ambulaeral perforations are small and narrow, elliptical; the posterior one is large and broad oval; its inner half within the ends of the posterior ambulaeral rays. The ambulaeral rays are elongated-oval; the posterior pair longest; the anterior-lateral pair shortest; each with a well-marked naked median line. Plates of the upper surface relatively more numerous than in *M. hexapora*, and narrower in the direction of the radii; four ambulaeral plates intervening between the perforations and the ends of the rays, while in *M. hexapora* of similar size there are but two. Spines of the upper surface close and short, slender at base, with greatly enlarged, rounded tips; those of the marginal fringe long, tapering, often acute; those of the median regions of the interambulaera are similar in form to those of the margin, but much more slender and delicate; those of the areas enclosed by the primary radiating grooves are very small and slender, not clavate.

Color, deep green when dried.

Zorritos, Peru, at low-water mark,—F. H. Bradley.

This species is allied to *M. hexapora* of the West Indies, but the latter is very distinct in the form of the posterior perforation, which is much more elongated and narrow, in adult specimens; in the ambulacral perforations, which are longer and larger; in the smaller number and larger size of the plates of the upper surface; in the longer spines of the upper surface, which have smaller tips; in the broader posterior-ambulacral rays; and in the more angular outline, which is distinctly truncate posteriorly.

Mr. A. Agassiz has mentioned by name *M. longifissa* Mich.,* as coming from Panama (Bulletin M. C. Z.), but whether his specimens are the same as the species here described I am unable to say, not having seen them. Dr. Lütken refers *M. longifissa* Mich., described without locality, to *M. pentapora*, with which it appears to agree far more nearly than with *M. Pacifica*. If the specimens of Mr. Agassiz prove to be distinct from our own, they probably will belong to a Pacific representative of *M. pentapora*, while *M. Pacifica* is the analogue of *M. hexapora*.

Stoloniclypeus rotundus A. Agassiz, Bulletin M. C. Z., p. 25, 1863.

Clypeaster Riisei Lütken, op. cit., p. 132. 1864.

Mr. Bradley collected numerous specimens of this species in Panama Bay, on shelly bottom in 6 to 8 fathoms, with *Encope occidentalis* and *Lytechinus roseus*. Mr. Agassiz collected his specimens at Acapulco. Dr. Lütken's example was from Panama.

One of the largest specimens is 5·4 inches in its longest diameter; 4·9 broad at the middle; ·75 high at center; ·3 at margin; from center to end of posterior lateral ambulacral rays 1·52; breadth of same ·8; of median area ·52; center to posterior margin 2·8; to anterior margin 2·6. The test is thin, somewhat oblong, depressed, except at the center, which is a little elevated. The margin is slightly undulated, curving somewhat inward at the interambulacral zones, and extending farther out in broad, slightly prominent lobes at the ambulacra, which are about three times as broad as the interambulacra at the margin. The posterior portion of the test is somewhat broader than the anterior; a slight lobe on the posterior margin, opposite the anal opening, which is circular and close to the edge. Ambulacral rays broad, subequal, forming a very regular rosette. The anterior one slightly narrower, and the anterior lateral pair slightly shorter than the posterior pair. The genital pores are close to the center, in the angles of a small pentagon. The ocular openings are scarcely visi-

* Specimens of this species have been received from Gulf of California and Nicaragua.—Reprint

ble to the unaided eye, nearer to the center than the genital pores. Spines uniformly crowded above and beneath, short and slender, the larger ones of the upper surface mostly with slightly enlarged tips. Color, in alcohol, dark ash-brown.

This species is allied to *S. prostratus* (Rav. sp.) of the West Indies, but has a thinner margin, broader ambulaera, a larger rosette, and a thinner test.

Pygorhynchus Pacificus (Ag. MS.) A. Agassiz, Bulletin M. C. Z., p. 27.

We have received from the Museum of Comparative Zoölogy, two specimens of this very interesting species, collected by Mr. A. Agassiz at Acapulco; and young specimens, from the Smithsonian Institution, collected at Cape St. Lucas by J. Xantus.

One specimen is 1·8 inches long; 1·4 broad; ·9 high; from center to anterior margin 1; to posterior margin 1·22; to anal orifice ·9; to end of anterior ambulaeral ray ·75; to end of anterior-lateral ·7; to end of posterior-lateral ·8; width of ambulaeral rays ·18; the median area ·1; width of actinal opening ·2; length ·12. Another specimen is 1·9 long; 1·6 wide; 1 high.

Test thin, concave beneath, the sides most prominent opposite the mouth; above regularly arched except at the anal region; marginal outline oblong, the ends obtusely rounded, the posterior portion broadest. Anal area transversely oval, situated in a depression above the margin. Ambulaeral rays nearly equal in width, the posterior ones longest; the anterior poriferous zones in the anterior-lateral ambulaera and the posterior zone in the posterior ones, shorter and narrower than the others. From the ends of the ambulaeral rays two single rows of pores may be traced around to the mouth, in most of the ambulaera. The actinal opening is wider than long, with five angles alternating with prominent lobes. One of the angles is on the anterior side, with a lobe opposite. A rosette of pores surrounds the mouth, each ray having two short rows of double pores and two rows of few, larger, single pores within them, and in the center another very short row of double pores, the pair next the mouth larger. The "naked space" beneath is broadest anteriorly, enclosing the mouth, and narrowing posteriorly. In life it is covered by minute spines. The spines of the upper surface are short and delicate, crowded; on the sides of the lower surface they are longer and larger, tapering, sharp at the ends, longitudinally fluted. Tubercles of the upper side small and regular; on the lower surface they are larger and snuken on the lateral parts; very small and unequal on the median area. Genital openings four, near the center. Color, when dried, brownish yellow. In alcohol, darker yellowish brown.

In form and general appearance this species resembles *Cassidulus Caribbeorum* Lamk.,* of the West Indies. The positions of the mouth and anal openings are nearly the same, and the latter is situated in a similar transverse depression surmounted by an arched, lip-like projection of nearly the same form, in each.

The *Cassidulus* differs, however, in several structural features of importance,—such as the number and arrangement of the pores in the rosette around the mouth, and in not having the pairs of pores in the dorsal rosette connected by transverse grooves, which, in *P. Pacifica*, are deep and conspicuous and separated by rows of small tubercles.

Brissus obesus Verrill, sp. nov.

Closely allied to *B. columbaris* of the West Indies, and *B. Scillæ*, Mediterranean, especially to the latter, from which it differs chiefly in its proportions (as seen in profile) and the position of the vertex.

The largest specimen is 2 inches long; 1.55 broad; 1.15 high, at the most elevated point; 1.35 from abactinal center to posterior margin; .92 to anterior margin; .65 to end of anterior-lateral ambulacra; .80 to end of posterior; .65 to end of anterior odd one (where crossed by fasciole); sub-anal fasciole .75 broad, .25 long; "plastron" 1.20 long; .70 broad at posterior end; mouth .40 broad.

Viewed from above the form is regularly ovate, except the narrower, posterior end, which is somewhat truncate and slightly emarginate at the anal area. Distance from abaetinal area to posterior end one and a half times that to anterior end. The abaetinal region is small and scarcely depressed. The posterior interambulacrum is elevated and swollen from its origin to the anal area, and subcarinated between the posterior ambulacra, causing the latter to appear unusually sunken. The region in front of the anterior lateral ambulacra is regularly and pretty uniformly rounded, lacking the flattened, somewhat depressed anterior area seen in *B. Scillæ*, and bears larger tubercles than the rest of the test, as in the allied species. The anterior odd ambulacrum is very narrow and scarcely depressed, with rather indistinct pores. Those of anterior pair are moderately long, lanceolate, nearly transverse, their ends curving somewhat toward the anterior end. Posterior-lateral ambulacra longer than anterior

* This species, which has recently been referred to *Rhyncopygus* by Dr. Lütken, was the type of the genus *Cassidulus* when it was first established in the *Système des Animaux sans Vertébrés*, p. 348, 1801. Therefore it seems most proper to restrict the genus *Cassidulus* to species like this.

(This name is preoccupied in mollusca. Mr. A. Agassiz has recently united this and *Pacificus* in a new genus, *Rhyncholampas*, Bulletin M. C. Z., p. 270,—Reprint.)

(in the ratio of 16 to 15) diverging at a smaller angle than in *B. Scillæ*. In a side view the anterior end has a regularly convex outline to the abactinal area, which forms a slight depression, from thence the outline rises gradually to a point about half way to the posterior end and then curves rapidly downward to the truncate anal region, which makes more than a right angle with the lower surface. Subanal region obtuse, high and inflated, very convex; posterior median region of the "*plastron*" inflated, rising into a prominent point. The sub-anal fasciole is broad, transversely reniform, its longitudinal diameter to its breadth as 1:3. The "*plastron*" is shield-shaped, rather broad, a little narrowed posteriorly, its length to breadth of posterior end as 12:7. Color of test, in alcohol, uniform yellowish gray; of spines, dark gray.

Gulf of California,—E. Samuels (Coll. Boston Soc. Nat. Hist. and Museum Yale College); Cape St. Lucas,—J. Xantus (Coll. Smiths. Institution).

This species is more liable to be confounded with *B. Scillæ* Ag. than with any other known to me. It may be distinguished readily, however, by its evenly rounded outline between the anterior margin and ovarian plates; by its more swollen posterior region, which is due both to the elevation of the posterior interambulacrum and the increased convexity of the sub-anal and ventral areas; by the less anterior position of the abactinal areas; by the relatively shorter and broader *plastron* and sub-anal fasciole; and by the latter being placed rather upon the posterior than upon the lower surface, while in *B. Scillæ* it is more nearly continuous with the *plastron*.

Mæoma nigra Verrill.

Kleinia (Ryssobrissus) nigra A. Agassiz, Bulletin M. C. Z., p. 27, 1863.

This large species is closely allied to *M. grandis* Gray, from Australia.

Length four inches; breadth 3.6; height 1.9; length of anterior lateral ambulacra 1.9; of posterior 2; length of anal area .7; breadth .45.

Its outline is broad ovate, somewhat cordate anteriorly, and truncate and slightly emarginate posteriorly. The upper surface is rather depressed, but not flattened, covered with scattered larger tubercles and very numerous small ones. The tubercles are largest within the peripetalous fasciole and beyond it on the posterior interambulacrum. The anterior ambulacral area is but little sunken, with rudimentary pores. The anterior-lateral ones are rather broad and deep, curving forward, especially at the ends. The two posterior are somewhat

longer, strongly divergent, obtuse at the ends. The posterior interambulacrum and the lateral pair are about equally swollen, within the fasciole, but the former is somewhat inflated beyond it, near the posterior end, which is obliquely truncated, the upper surface projecting considerably beyond the lower. The anal area is large, elliptical, acute above, and occupies the greater part of the truncated posterior end.

The peripetalous fasciole is nearly transverse anteriorly, but forms two abrupt, angular bends between the anterior and lateral ambulacra, of which that next to the lateral extends much farther toward the summit. In the rest of its course it agrees very nearly with that of *M. grandis* as figured by Gray.* The sub-anal fasciole is nearly transverse between the posterior ambulacra; at a distance from the anal area about equal to the length of the latter, each end bends obliquely upward laterally and becomes irregular and gradually disappears opposite the sides of the anal area and at some distance from it, without enclosing a sub-anal area. Genital openings four, the two posterior largest and farthest apart.

Acapulco, Mexico,—A. Agassiz. In exchange from the Museum of Comparative Zoölogy.†

I am indebted to the kindness of Mr. A. Agassiz for a typical specimen of this interesting species. It seems to be a true *Meoma*.

Metalia Gray.

Brissus (subgenus *Metalia*) Gray, Catalogue of the Recent Echinida of the British Museum, p. 51, 1855.

Xanthobrissus A. Agassiz, Bulletin M. C. Z., p. 28, 1863.

The first division of the genus *Brissus*, as limited by Dr. Gray, contained only one species, the *B. sternalis* Ag. This group, to which he applied the name *Metalia*, he characterized as follows: "Subanal area heart-shaped, edged by a broad subanal fasciole; the disk radiated, striated, with a series of marginal pores, and with a short fasciole, branched up and edging the sides of the vent; the hinder part of the peripetalous fasciole slightly bent, but not margined to the hinder edge of the hinder ambulacra; spines on the side of the ambulacra larger, elongate."

This division appears to be perfectly equivalent to *Xanthobrissus* A. Agassiz. The type of the latter, *M. Garretii* (Ag. sp.), from the Kingsmills Islands, is closely allied to *M. sternalis*, as I have ascertained by an examination of typical specimens of the former, belong-

* Catalogue of the Recent Echinida of the British Museum, Part 1, pl. 5, fig. 2, 1855.

† More recently sent by J. Pedersen from La Paz,—Reprint.

ing to the Boston Society of Natural History and the Essex Institute, received from the Museum of Comparative Zoölogy. Whether it be really distinct can be ascertained only by an actual comparison of authentic specimens of each, the descriptions of *M. sternalis* not being sufficient to distinguish it from *M. Garretii*.

Metalia nobilis Verrill, sp. nov.

Test depressed above, most elevated at the abaetinal pole and upper part of posterior interambulaerum; anterior end arched; posterior end obliquely truncate; lower surface but little convex. In a view from above the form is very broad oval, the anterior end a little emarginate, the posterior truncate, but prominent.

Extreme length 4.5 inches; breadth 4; height 2.2; from abaetinal pole to anterior end 2; to posterior end 3.1; to end of anterior ambulaeral rays 1.7; to end of posterior 1.92; to peripetalous fasciole in posterior interambulaerum 1.5; in lateral interambulaera 1.3; in anterior ambulaerum 1.7; length of anal area .62; breadth .52; length of subanal fasciole .88; breadth 1.35; from anal area to fasciole .25; mouth to subanal fasciole 2.45; breadth of plastron 1.25; length of spines of lower surface .55; of upper surface bordering ambulaera .22.

The anterior ambulaerum is but slightly sunken; the lateral ones in deep grooves, nearly uniform in width; the anterior pair nearly straight; the posterior curving slightly outward. The lateral and posterior interambulaera are convex within the peripetalous fasciole, but beyond this the latter is suddenly depressed, causing a slightly concave place, behind which it is slightly convex, and slopes gradually to the posterior end. The peripetalous fasciole is nearly transverse in front, bending upward for a short distance, nearly at a right angle, about at the middle of the anterior-lateral interambulaera, and then turning back again at a similar angle, passes close by the end of the ambulaeral rays. In the lateral and posterior interambulaera it bends but slightly upward, and does not margin the ambulaera. The sub-anal fasciole is rather large, broader than long, broad heart-shaped, the lower end terminating in a slight point, the lower sides rounded to the extreme lateral lobes; the upper or posterior side with a straight line in the middle, and slightly concave ones running to the lateral lobes. From each end of the straight, posterior part a narrow fasciole passes outward and upward in a broad curve and terminates about opposite the middle of the anal area. The anal area is broad-oval, longer than broad. The plastron is elliptical, but little convex, the most prominent points being at the posterior

end, where the subanal fasciole crosses it, and at the mouth. Pores around the mouth large, in five conspicuous rays. The spines are long and slender on the lower surface, short and fine above, except on the borders of the ambulacra and within the fasciole, where the tubercles are considerably larger.

Color of test dark ash-brown, a yellowish white line or narrow band passing from the ambulacral petals or rays to the outer margin, along each border of the ambulacral zones. Color of spines very dark gray, or blackish.

A small specimen from Cape St. Lucas is 1.55 inches long; 1.4 broad; .88 high; from center to end of anterior ambulacral rays .52; of posterior .57; width of latter .12; center to anterior end 1.7; to posterior end 1.3; length of area within subanal fasciole .4; breadth .45.

In form this agrees nearly with the large specimen, except that the posterior interambulacral region is depressed within the peripetalous fasciole and the lower surface is more convex, the plastron being subearinated and most prominent in the middle. The anterior, odd ambulacrum is scarcely depressed below the general surface.

The form of the peripetalous fasciole is the same as in the large specimen. Color of test and spines, in alcohol, is white, the spines transparent.

Panama Bay, dredged in 6 to 8 fathoms, shelly bottom,—F. H. Bradley. Cape St. Lucas,—J. Xantus (Coll. Smithsonian Inst.).

This species is allied to *M. Garretii* of the Kingsmills Islands, but the latter differs in having a more elevated and convex form, especially posteriorly; in having the anterior end high and abruptly descending, with the imperfect ambulacrum in a deeper groove; in having relatively shorter and broader ambulacral rays, which are not so uniform in width, and the posterior ones more curved; in the form of the anal area, which is pointed below, instead of rounded; in the subanal fasciole, which is smaller, narrower, and more rounded, being about as long as broad. The peripetalous fasciole bends up in an abrupt angle in the lateral interambulacra, instead of crossing in a broad, slightly concave curve.

Agassizia ovulum Lütken, Vidensk. Medd., p. 134, tab. II, fig. 8, 1864.

Mr. Bradley sent one specimen of this species, found on the beach at Panama. Dr. Lütken's specimens came from Boccones, Central America.

Order, HOLOTHURIOIDEA.

A large number of Holothurians, representing numerous species, from Panama, San Salvador, etc., were collected by Mr. Bradley. But since it is very difficult to properly characterize animals of this order from specimens preserved in alcohol, most of these species are here omitted. The Holothurians of other localities have, also, been so imperfectly described that descriptions of those of this region would at present afford but little additional evidence upon questions of Geographical Distribution.

Most of the species in the collection belong to the restricted genus *Holothuria*, and allied genera, having twenty peltate tentacles.

Two of the more interesting and unusual forms are described below. It is to be hoped that examinations of the living animals will soon afford material for completing the descriptions of these, as well as of the remaining species.

Pentacta Panamensis Verrill, sp. nov.

Body somewhat fusiform, pentagonal, the angles prominent, both ends turned upward. Length, in alcohol, 1.4; diameter at middle .28. Suckers not entirely retractile, arranged along the angles. In the three lower ambulacra there are two alternating rows on each angle, along the middle of the body, but toward each end they become more distant, smaller, and form but a single row; on the two ambulacra of the upper side they are less numerous and form a single row along the whole length of the body. The suckers are stiff at the lower part, and filled with calcareous grains; the ends are soft and extensible, with well developed disks. The interambulacral zones are smooth and without papillæ; the skin thin, coriaceous, filled with very numerous, minute, calcareous grains or plates. The anal opening is surrounded by ten small papillæ. Tentacles ten, the two lower ones much the shortest, all arborescently branched, the numerous ultimate divisions forming, in contraction, clusters of small rounded papillæ on the branches.

Color, in alcohol, grayish brown, the tentacles yellowish brown.

Panama,—F. H. Bradley, one specimen.

The extensive group of Holothurians referred to *Pentacta* by some authors, and by others to *Cucumaria*, appears to include several distinct generic types. The present species is closely allied to *P. pentactes* Jæg., of Europe, properly the type of the genus *Pentacta*, which should, therefore, be restricted to those species which have a pentagonal form, with suckers confined to the angles, and smooth

interambulacra. In the same manner *Cucumaria* may be restricted to the group having *C. frondosa* as its type. In these the form is more swollen and rounded; the suckers wholly retractile, in five zones; the interambulacral zones provided with few scattered papillæ.

Anaperus Peruanus Troschel, Wieg. Arch. xii, p. 61, 1846.*

Holothuria peruviana Lesson, Cent. Zool., pl. 46, p. 124.

Thyone peruana Selenka, Zeitschrift für Wissenschaft. Zoologie, 1867, p. 354.

Several large examples of this species were obtained by Mr. Bradley both at Paita and Callao, Peru.

This species may be regarded as the type of the genus *Anaperus* of Troschel, it being the first species mentioned by him. It is allied to *A. Briareus* (*A. Carolina* Tr.) from the Carolina coast, Long Isl. Sound, etc.

Lissothuria Verrill, gen. nov.

Allied to *Psolus*, but having the upper surface of the body covered with a soft, smooth skin in which are imbedded minute perforated plates. Lower surface flat, with three broad rows of crowded suckers. Anal area elevated, the opening surrounded by calcareous papillæ. Tentacles ten, arborescently branched, the two lower ones smallest.

Lissothuria ornata Verrill, sp. nov.

Body elongated, depressed, the flat lower surface broad; the anterior end elevated; the anal area near the high posterior end, little elevated above the surface of the back. Length 2.1; breadth .85; height .35; length of lower surface 1.7; breadth .85.

The anterior end, bearing the tentacles, rises considerably above the level of the back, and where it joins the naked part below the tentacles there is a ring of calcareous plates, with pointed ends, and on the upper side four, elongated, flexible papillæ rising from enlarged bases having calcareous grains, apparently corresponding to four of the ambulacra. The tentacles are arborescently branched, not large, the subdivisions in contraction forming a rounded cluster, on a stout pedunculated base. Anal region conical, opening posteriorly. Suckers of the lower surface small and very numerous, crowded, six or eight series in each ambulacrum. The skin above is soft, but filled with minute calcareous grains and fewer, somewhat larger, perforated ones.

Color, in alcohol, light purple, whitish beneath, disk purple, with a yellowish white ring around the mouth; tentacles purple at base, the subdivisions yellowish.

Panama, one specimen,—F. H. Bradley.

* This belongs to the genus *Pattalus* (see page 376).—Reprint.

No. 3. *On the Geographical Distribution of the Echinoderms of the West Coast of America.*

Published July, 1867.

Although a large proportion of the Echinoderms inhabiting this coast were long since described, very little has been done toward the study of their distribution, and comparisons with the Echinoderm Faunæ of other regions.

It is certain that our knowledge of the species inhabiting the various districts upon this coast is still quite imperfect, for even the collection of Mr. Bradley contains several undescribed species from Panama, which was the region previously best known. But since the collections which he has made, and those made by Mr. J. Xantus at Cape St. Lucas, have contributed a large amount of new and authentic materials for such investigations, it is thought proper to introduce here a brief account of what is already known concerning this interesting and important subject.

The distribution of the species of the West Coast of America should be studied with reference to several questions:—

First.—To ascertain the range of each species along the coast, both geographically and in the depth.

Second.—To ascertain the extent and boundaries of the several faunæ, which occupy the coast.

Third.—To compare these faunæ with those of other regions,—especially the tropical fauna of the West Coast with that of the East Coast and West Indies, and with that of the Pacific Islands and East Indies.

Fourth.—To compare the living species with those found fossil in the Tertiary and more recent formations of the neighboring coasts, and of the West Indies and Eastern North America.

Very little material is now accessible for the investigation of the subject included under the fourth head, but since prolific fossiliferous deposits are known to occur near Aspinwall, as well as along the western coast of South America,* many important results may be expected when such localities shall have been fully investigated.

The principal sources of information concerning the existing faunæ of the coast have, hitherto, been the works of Brandt¹ for the north-

* A deposit abounding in fossils was examined by Mr. Bradley near Zorritos, Peru, which is apparently of late Tertiary age, but the collection has not yet been examined with care. (See vol. ii,—Reprint).

¹ Prodrômus descriptionis animalium ab H. Mertensio in orbis terrarum circumnavigatione observatorum. Recueil des Actes de la séance publique de l'académie impériale de St. Petersburg, 1825.

ern district; Dr. William Stimpson² for the Coast of Oregon and California; D. J. E. Gray,³ Dr. Chr. Lütken,⁴ and Mr. A. Agassiz⁵ for the tropical region; Valenciennes⁶ and Agassiz and Desor⁷ for the Galapago Islands and coast of Peru; Philippi⁸ for the coast of Chili and southward to the Straits of Magellan. Dr. Lütken has given lists of all the species of Echini and Starfishes known upon the whole coast at that time, but numerous discoveries have been made since the publication of his valuable papers. Mr. Theodore Lyman⁹ has given a list of all the known Ophiurians, with descriptions of all the America species which he has personally examined.

From these and other works, and from the collections of the Yale College Museum, the Smithsonian Institution, the Boston Society of Natural History, and the Essex Institute, the following lists have been compiled.

Care has been taken not to admit doubtful species, and those apparently without sufficiently authentic localities. The few species included in the lists of which the localities are questionable or suspected are preceded by a mark of doubt, thus, (?); those that I have personally studied are marked thus, (!).

List of species found at Sitcha.

ASTERIOIDEA.

Asteropsis imbricata Grube.

Patiria miniata (*Asterias miniata* Brandt). Extends south to Monterey.

Solaster decemradiatus (Brandt sp.) Stimpson.

Pycnopodia helianthoides (Brandt sp.) Stimpson. Extends to Tomales Bay, Cal.

² The Crustacea and Echinodermata of the Pacific Shores of North America. Journal of the Boston Society of Natural History, vol. vi, 1857. Proceedings Bost. Soc. N. H., vol. viii, p. 261, 1861.

³ Synopsis of the genera and species of the Class Hypostoma (*Asterias* Linn.). Annals and Magazine of Natural History, vi, 1840. Numerous starfishes from the collection of Hugh Cuming are briefly described in this paper.

⁴ Videnskabelige Meddelelser fra den naturhistoriske Forening i Kjøbenhavn. Bidrag til Kundskab om Ophiurerne ved Central-Amerikas Vestkyst, 1856. Bidrag til Kundskab om de ved Kysterne af Mellem-og Syd-Amerika levende Arter af Sostjerner, 1858. Bidrag til Kundskab om Echiniderne, 1864. Kritiske Bemærkninger om forskjellige Söstjerner (Asterider), med Beskrivelse af nogle nye Arter, 1864.

⁵ Bulletin of the Museum of Comparative Zoölogy, No. 2, 1863.

⁶ Voyage autour du Monde sur la frégate la Vénus par Petit-Thouars, Atlas de Zoologie, Zoophytes, 1846.

⁷ Catalogue raisonné des familles, des genres et des espèces de la classe des Echinodermata. Annales des sciences naturelles, 3^{me} serie, Zoologie, t. 6, 7, 8, 1847.

⁸ Vier neue Echinodermen des Chilenischen Meeres. Archiv für Naturgeschichte, Bd. xxiii, 1857, p. 130.

⁹ Illustrated Catalogue of the Mus. Comp. Zoölogy, No. I, 1865.

Asterias ochracea Brandt. Found also at San Francisco and Tomales Bay.

Asterias epichlora Brandt.

ECHINOIDEA.

Dendraster excentricus (Esch. sp.) Ag. From Unalaska to Monterey, Cal.

Euryechinus Dröbachiensis V.? (*E. chlorocentrotus* Brandt sp.). Mr. A.

Agassiz considers this the same as *E. Dröbachiensis* of the North Atlantic. It is found as far south as the Gulf of Georgia.

HOLOTHURIOIDEA.

Chirodota discolor Esch.

*Leptosynapta verrucosa** (nobis), (*Chirodota verrucosum* Esch., Zoöl. Atlas, Tab. X, fig. 3).

Liosoma Sticheuse Brandt.

Psolus Sticheusis Duj. et Hupé, (*Caviera* Brandt). Whether this be a true *Psolus* can be ascertained only by reëxamination.

Pentacta albida (Brandt sp.) Stimp.

P. nigricans (Br. sp.) Stimp.

P. miniata (Br. sp.) Stimp.

Aspidochir Mertensii Brandt.

Diploperideris Sticheusis Brandt, (? *Holothuria*).

Six species included in the above list reach Puget Sound, and five extend to Tomales Bay and San Francisco. The species now considered peculiar are chiefly Holothurians and probably many of them will hereafter be found farther south, while others may prove identical with the arctic species of the North Atlantic.

List of species found in Puget Sound and along the coast to Cape Mendocino, Cal.

OPHIUROIDEA.

Ophioglypha Lütkenii Lyman. Puget Sound.

Ophiopholis Kennerleyi Lyman! Puget Sound; Dungenes, Or. (Yale Mus.); Mendocino.

Amphiura Pugetana Lyman. Puget Sound and Mendocino.

A. occidentalis Lym. Puget Sound to Monterey, Cal.

A. urtica Lym. Puget Sound.

Astrophyton sp. (? *A. Crayi* Lym.). Puget Sound (Dr. Stimpson).

* Under the generic name, *Leptosynapta*, I propose to separate from the typical species of *Synapta* (*S. mammillosa* Esch.), such species as *S. tenuis* Ayres of New England, and *S. inharrens* of Europe. These are distinguished by their more slender form, the absence of prominent verrucae, fewer (12), shorter and more digitate tentacles, etc. *L. tenuis* may be regarded as the type. Eschscholtz himself referred such species to his genus *Chirodota*, from the typical species of which they differ in having minute calcareous hooks in the skin for adhesion. The typical species of *Synapta* have fifteen tentacles, and prominent verrucae.

ASTERIOIDEA.

Mediaster aequalis Stimp. Puget Sound to San Francisco.

Patiria miniata (Brandt sp.). Sitcha to Isl. San Miguel.*

Cribrella leviuscula (Linckia leviuscula Stimp.). Puget Sound; Dungenes, Oregon (Coll. Yale Mus.).

Pycnopodia helianthoides Stimp.

Asterias epichlora Brandt. Puget Sound (Stimpson); mouth of Columbia River (*A. Katherineæ* Gray).

A. ochracea Brandt.

A. conferta Stimpson. Puget Sound.

A. fissispina Stimp. Shoalwater Bay, Oregon.

A. Lutkenii Stimp. Oregon.

A. paucispina Stimp. Puget Sound.

A. Troschelii Stimp. Puget Sound.

A. hexactis Stimp. Puget Sound.

ECHINOIDEA.

Dendraster excentricus Agassiz.

Euryechinus Dröbrachiensis Verrill. (?) (*E. chlorocentrotus* Brandt). Gulf of Georgia; Vancouver's Island.

HOLOTHURIOIDAE.

Pentacta piperata Stimp. Puget Sound.

P. populifera Stimp. Puget Sound.

P. albida Stimp. California (Selenka).

P. quinquesemita (Selenka sp.) Mendocino.

Synapta albicans Sel. Mendocino.

Of the 25 species in this list, 16 have not been recorded from south of Mendocino; and 18 are not known north of Puget Sound; 15, so far as yet known, are peculiar to this district.

List of species found between Cape Mendocino and San Diego, Cal.

OPHIUROIDEA.

Ophiopholis Caryl Lym. San Francisco.

Amphiura occidentalis Lym. Monterey and northward.

Ophiothrix dumosa Lyman. San Diego, Cal.

Astrophyton Caryl Lym. San Francisco.

ASTERIOIDEA.

Mediaster aequalis Stimp. San Francisco.

Patiria miniata (Brandt sp.). Tomales (or Bodega) Bay; San Francisco; Isl. San Miguel.

* This Island is one of the most northern of the Santa Barbara group.

Pycnopodia helianthoides Stimp., Tomales Bay.

Asterias gigantea Stimp., Tomales Bay.

A. brevispina Stimp., San Francisco (10 fathoms, sandy bottom).

A. ochracea Brandt, San Francisco at low water ! Tomales Bay ! northward.

A. capitata Stimp., San Diego, Cal.

A. æqualis Stimp., Monterey, Cal.

ECHINOIDEA.

Dendraster excentricus Ag., from Monterey northward !

Loxechinus purpuratus A. Ag., San Francisco, on rocks at low-water !

Toxopneustes Franciscana (*Toxocidaris franciscana* A. Ag.), S. Francisco !

HOLOTHURIOIDEA.

Liosoma arenicola Stimp., San Pedro, Cal.

? *Cucumaria frondosa* Bv., San Francisco.

Holothuria Californica Stimp., Tomales Bay.

Of the 18 species in this list, 10 do not appear to have been, as yet, found north of Tomales Bay, while 6 extend northward to Puget Sound. *Astrophyton Caryi* may, also, prove to be the same species as the one indicated from Puget Sound. "*Cucumaria frondosa*" may prove identical with one of the species from Sitcha, described by Brandt, but if correctly identified it is a true circumpolar species and must be supposed to exist along the whole coast northward from San Francisco. Two species have not been found north of San Diego.

None of the species in the above list have been found at Cape St. Lucas, except *Ophiothrix dumosa*.

Concerning the Echinoderms found between San Diego and Margarita Bay, Lower California, we have no information whatever.

The special localities of the following species are unknown. It is quite probable that some of them belong to the fauna of Lower California.

Chætaster Californicus Grube, "California."

Cidaris Danæ Ag., California (Ag. and Des. Catal.).

Astriclypeus Mannii Verrill, West Coast of America (?)*

List of species found at Margarita Bay and Cape St. Lucas.

OPHIUROIDEA.

Ophiura Panamesis Lyman.

O. teres Lyman.

Ophiocoma æthiops Lütken.

O. Alexandri Lyman.

Ophiactis virescens Lütken.

* Dr. F. H. Troschel gives Yokohama, Japan, as the locality of this species.—Reprint.

Ophionereis Xantusii Lyman, Cape St. Lucas.

O. annulata Lyman.

Ophiothrix spiculata LeC.

O. dumosa Lyman, Cape St. Lucas, San Diego, Guayamas.

ASTERIOIDEA.

Astropecten Örstedii Lütken!

Nidorellia armata Gray!

Oreaster occidentalis Verrill, Cape St. Lucas and Panama!

Linckia unifascialis Gray!

Do. var. bifascialis Gray!

Ophidiaster pyramidatus Gray!

Heliaster microbrachia Xantus, Cape St. Lucas and Panama.

H. Kubiniji Xantus! Cape St. Lucas.

Asterias sertulifera Xantus, Cape St. Lucas.

ECHINOIDEA.

Cidaris Thouarsii Val.!

Diadema Mexicana A. Ag., Cape St. Lucas and Acapulco!

Echinodiadema coronata Verrill, Cape St. Lucas!

Echinocidaris stellata Agassiz, Margarita Bay! Cape St. Lucas! Guayamas, and south to Paita, Peru!

Psammechinus pictus Verrill, Cape St. Lucas.

Echinometra Van Brunti A. Ag., Cape St. Lucas and Acapulco!

Encope sp.*

Pygorhynchus Pacificus Ag., Cape St. Lucas and Acapulco!

Metalia nobilis Verrill, Cape St. Lucas and Panama!

Brissus obesus Verrill, Cape St. Lucas and Gulf of California!

Species given in this list without special localities extend as far southward as Panama or beyond. Of the 27 species here recorded, 17 reached Panama; 3 have been found elsewhere only at Acapulco; 2 only at Cape St. Lucas and in the Gulf of California; and 5 have, as yet, been recorded only from Cape St. Lucas. The only species known to me from Margarita Bay is *Echinocidaris stellata*, which has also the most extensive range southward. *Ophiothrix dumosa*, alone, is included both in this and the preceding list.

List of species found at Acapulco, Mazatlan, and in the Gulf of California.

OPHIUROIDEA.

Ophiura Panamensis Lym., Acapulco and southward!

O. teres Lym., Acapulco and southward!

* Since described as *Encope Californica* V. Common at La Paz, J. Pedersen,—Reprint.

Ophiocoma athiops Lütke., Acapulco and southward!

O. Alexandri Lym., Acapulco and southward!

Ophiothrix dumosa Lym., Guayamas to San Diego.

ASTERIOIDEA.

Nidorellia armata Gray, Guayamas! (Bost. Soc. N. H.)

Linckia unifascialis Gray, Acapulco and southward!

Heliaster sp. = (*H. Kubiniji* ?). Acapulco and Mazatlan. Dr. Stimpson records *H. helianthus* from Mazatlan, but this is probably an erroneous identification.

ECHINOIDEA.

Diadema Mexicana A. Ag., Acapulco! Cape St. Lucas!

Echinocidaris stellata Ag., Guayamas and southward!

Lytechinus roseus Verrill, Acapulco and Panama!

Tripneustes depressus A. Ag., Guayamas! La Paz!

Toxopneustes sp. (*Toxocidaris mexicana* A. Ag.), Acapulco.

Echinometra VanBrunti A. Ag., Acapulco! and Cape St. Lucas!

Stoloniclypeus rotundus A. Ag., Acapulco (A. Ag.), Panama!

Encope grandis Ag., Head of the Gulf of California!

Pygorhynchus Pacificus Ag., Acapulco and Cape St. Lucas!

(?) *Mora clotho* Mich., Mazatlan.

Lovenia sp., Gulf of California!

Meoma nigra Verrill, Acapulco!

HOLOTHURIOIDEA.

Stichopus Kefersteinii Selenka. Acapulco.

Holothuria lubrica Selenka. Acapulco.

Stolus ovulum Selenka. Acapulco.

This list, which is doubtless very imperfect,* includes 23 species, of which 9 are found also at Panama; 5 are found at Cape St. Lucas; the remaining 9 are, so far as known, peculiar to this district, but future researches will probably reduce the number, since the coast of Mexico and Central America has been little explored.

List of species of the West Coast of Central America and the Bay of Panama.

OPHIUROIDEA.

Astrophyton Panamense Verrill, Panama and Zorritos, Peru!

Ophiura teres Lyman, Cape St. Lucas to Panama!

O. Panamensis Lym., Cape St. Lucas to Panama!

O. variegata Lym., Realejo and Panama!

O. Daniana Verrill, La Union!

* Many additional species have recently been sent from La Paz by J. Pedersen, lists of which will be found in articles 5 and 8,—Reprint.

- O. sp. nov.* (see page 270), Panama!
Ophiolepis variegata Lützk., La Union! Realejo. Panama!
Ophiozona Pacifica Lym., Punta Arenas. Panama!
Ophiocoma aethiops Lützk., Cape St. Lucas to Panama!
O. Alexandri Lym., Cape St. Lucas to Panama!
Ophionereis annulata Lym., Cape St. Lucas to Panama!
Ophiocnida hispida Lym., Panama!
Ophiostigma tenue Lützk., Realejo.
Amphiura geminata Lützk., Panama!
A. violacea Lützk., Realejo. ? Panama!
A. Puntarenæ Lützk., Punta Arenas. Panama!
A. microdiscus Lützk., Punta Arenas.
A. Örstedii Lützk., Punta Arenas.
Ophiophragmus marginatus Lym., Realejo.
Hemipholis gracilis Verrill, Panama!
Ophiactis virescens Lützk., Punta Arenas. Panama!
O. simplex Lützk., Nicaragua. Panama!
 (?) *O. Örstedii* Lützk., Punta Arenas.
O. arenosa Lützk., Punta Arenas. Realejo. ? Panama!
Ophiothrix spiculata LeC., Cape St. Lucas to Zorritos, Peru!
Ophiothela mirabilis Verrill, Panama!
Ophiomyxa sp., Punta Arenas (Lütken).

ASTERIOIDEA.

- Luidia tessellata* Lützk., Acajutla to Panama!
 (?) *Petalaster Columbiæ* Gray, San Blas.
Astropecten fragilis Verrill, Panama and Zorritos!
A. regalis Gray, San Salvador! Panama! San Blas.
A. Örstedii Lützk.,* Cape St. Lucas to Panama!
Patiria obtusa Gray, Panama!
Asteriscus modestus Verrill, Panama!
Gymnasteria spinosa Gray, Panama.
G. inermis Gray, Panama.
Nidorellia armata Gray, Guayamas to Zorritos!
Oreaster occidentalis Verrill, Cape St. Lucas and Panama!
Linckia unifascialis Gray, Cape St. Lucas to Zorritos!
Ophidiaster pyramidatus Gray, same range as last!
Mithrodia Bradleyi Verrill, Panama!

* A typical specimen of this species received from Dr. Lütken, while agreeing in most characters with those described in the preceding article (page 274), differs in having much smaller and shorter spines both above and below, the inner row on the upper marginal plates not reaching beyond the seventh or eighth plate, and in having the terminal papillæ of the paxillæ considerably finer, while the paxillæ are also smaller and shorter. This specimen being somewhat smaller (greater radii 2.15 inches), these differences may be due to age.

Echinaster aculeatus (Gray, sp.) Lützk., Guacomajo.

Heliaster microbrachia Xantus, Cape St. Lucas and Panama!

ECHINOIDEA.

Cidaris Thoursii Val., Cape St. Lucas to Panama! Galapagos.

Astropyga venusta Verrill, Panama.

Echinocidaris stellata Ag., Guayamas to Zorritos and Paita!

Lytechinus roseus Verrill, Acapulco and Panama!

Echinometra rupicola A. Ag., Acapulco and La Union to Zorritos!

Encope occidentalis Verrill, Panama and Zorritos! Galapagos.

Echinoglycus Stokesii Gray, Punta Arenas! Panama! Galapagos.

Mellita longifissa Mich., Panama, A. Ag.*

Stoloniclypeus rotundus A. Ag., Acapulco. Boccones. Panama!

Metalia nobilis Verrill, Cape St. Lucas and Panama!

Agassizia ovulum Lützk., Boccones. Panama!

HOLOTHURIOIDEA.

Holothuria languens Selenka. Panama.

H. subditiva Sel., "Panama (Florida?)."

(?) *H. glaberrima* Sel., Panama, West Indies.

(?) *H. botellus* Sel., Panama, also Florida, Sandwich Is., Zanzibar, etc. (Selenka).

Pentacta Panamensis Verrill, Panama!

Lissothuria ornata Verrill, Panama!

Stolus gibber Sel., Panama.

The above list includes 61 species, of which 6 are known to extend from Cape St. Lucas to Zorritos, Peru, and one of these even from Guayamas to Paita; 36 species range from Panama northward along the Coast of Central America; 12 at least, extend from Panama southward to Ecuador and northern Peru, but this number will, doubtless, be greatly increased by farther explorations, for only two Ophiurians are known to me from the region between Panama Bay and Paita. 15 species are, as yet, known only from Panama Bay;† and 9 have been found only on the coast of Central America.

These figures must be taken only as an indication of the present state of our knowledge of this fauna,—not as representing the actual condition, for it must be remembered that while the Echinoderms have as yet been but partially collected at any point, the collections from Panama have been most complete, but those from Central America have also been much more so than those made south of Panama.

The Holothurians, considered by Selenka as common to Panama and the West Indies, or the Indian Ocean, need reëxamination, from

* This species with *Encope occidentalis* and *Echinometra rupicola* were collected at Corinto, Nic., by J. A. McNiel.—Reprint.

† This number has since been reduced to 9,—Reprint.

authentic specimens, before all doubt can be removed concerning these conclusions, which are at variance with the distribution of the other Echinoderms.

List of Species from the West Coast of Ecuador and southern part of New Granada.

OPHIUROIDEA.

Astrophyton Panamense Verrill, Zorritos and northward!

Ophiothrix spiculata LeC. This and the preceding are introduced here because found both at Panama and Zorritos.

ASTERIOIDEA.

Luidia Bellonæ Lützk., Guayaquil (Lützk.). Callao! (Yale Mus.).

Astropecten armatus Gray, (non Müll. and Tr.), Puerto Portrero.

A. erinaceus Gray, Punta Santa Elena.

A. fragilis Verrill, Zorritos and northward! (Yale Mus.).

Paulia horrida Gray, Puerto Portrero.

Nidorellia armata Gray, Punta Santa Elena.

Oreaster Cumingii (Gray sp.) Lützk., Punta Santa Elena.

Ophidiaster pyramidatus Gray, Bay of Caraccas.

Linckia unifascialis Gray, " "

L. Columbiæ Gray, West coast of Columbia.

Cistina Columbiæ Gray, " " "

Dactylosaster gracilis Gray, West coast of Columbia.

Ferdina Cumingii Gray. " " "

(?) *Acanthaster Ellisii* (*Echiniaster Ellisii* Gray), "South America."

ECHINOIDEA.

Echinocidaris stellata Ag., Paita and northward!

Echinometra rupicola A. Ag., Zorritos and northward!

Echinoglycus Stokesii Gray, Guayaquil and northward!

Encope occidentalis Verrill, Zorritos and northward!

The Asteroidea in the above list are inserted upon the authority of Dr. Gray, from the collection of H. Cuming, unless otherwise indicated. The Echinoidea, although mostly unrecorded from this region, are found beyond it upon both sides and are, therefore, inserted here. The Ophiurans and Holothurians are almost unknown. Of the 20 species enumerated, 10 are found at Panama; 2 are doubtful inhabitants of this district, and the remaining 8, unless some of them be synonymous with Panama species, are still known only from this coast. These peculiar species, which are all Asteroidea, were mostly obtained by Mr. Cuming by dredging, and may hereafter be found by similar search at Panama.

*List of Species found at Zorritos, Peru.**

OPHIUROIDEA.

Astrophyton Panamense Verrill!*Ophiothrix spiculata* LeC.!

ASTERIOIDEA.

Astropecten fragilis Verrill!*Nidorellia armata* Gray!*Linckia unifascialis* Gray!*Ophidiaster pyramidatus* Gray!*Heliaster Cumingii* Gray, Zorritos! Paíta! Galapagos.

ECHINOIDEA.

Echinocidaris stellata Ag.!*Echinometra rupicola* A. Ag.!*Mellita Pacifica* Verrill!*Encope occidentalis* Verrill!

Of the 11 species in this list, 9 are found as far north as Panama, or beyond,—5 even occurring at Cape St. Lucas.† *Mellita Pacifica* is not yet known elsewhere; *Heliaster Cumingii* and *Echinocidaris stellata* are also found at Paíta. All the species of this list are in the Museum of Yale College.

List of species recorded from the Galapago Islands.

ASTERIOIDEA.

(?) *Culcita Schmideliana* Gray, "Lord Hood's Island on Reefs, *H. Cumingii*" (Gray).

Heliaster Cumingii Gray, "Hood's Island" (Gray).

H. multiradiata Gray, "Hood's Island" (Gray).

(?) *Acanthaster Ellisii* Gray. *Stilifer astericola* Brod., is recorded as parasitic in "*Asterias solaris*" from Lord Hood's Island, Gal., Proc. Zool. Soc. London, 1832, p. 60.

ECHINOIDEA.

Cidaris Thouarsii Val., Panama! etc.

Echinocidaris stellata Ag., Panama! etc.

(?) *Lytechinus semituberculatus* Val., (?) *L. roseus*).

(?) *Euryechinus imbecillis* Verrill, (*Echinus gibbosus* Val.).

Anthocidaris homalostoma (Val. sp.) Lütke.

Temnopleurus botryoides Ag.

Amblypneustes pallidus Ag.

A. formosus Val.

* Zorritos is situated 25 miles south of Tumbes, Peru.

† Eight of these species are found at La Paz,—Reprint.

Echinoglycus Stokesii Gray, Panama! etc.

Encope occidentalis Verrill, Panama! etc.

In this list are 14 species, of which 6 do not appear to have been found on the American coast, and three others are doubtful; 4 occur at Panama, and are species of wide range along the coast, while *Heliaster Cumingii* is found at Zorritos and Paita. "*Echinus gibbosus*," if correctly identified, occurs also at Paita and Callao.

This list, though very incomplete, indicates that the Echinoderm fauna of the Galapagos is of a mixed character, having the closest relations with that of Panama Bay, but at the same time including species belonging to the more temperate waters of Peru, and a large proportion that are peculiar to the group. Most of the peculiar species resemble Pacific and East Indian forms rather than American. Such are the species of *Amblypneustes*, *Temnopleurus*, *Culcita*,—genera which have not been found upon either the East or West coast of America. On the contrary, *Heliaster*, *Echinocidaris*, *Lytechinus*, *Echinoglycus*, *Encope* are very characteristic American genera.

List of species found on the coast of Peru, at Paita and southward.

OPHIURIOIDEA.

Ophiactis Kroyeri Lützk., Callao!

Ophiothrix magnifica Lym., Peru (Lyman). Paita!

ASTERIOIDEA.

Luidia Bellonæ Lützk., Callao! (Yale Museum).

Astropecten Peruanus Verrill, Paita!

Asteriscus (Patiria) Chilensis Lützk., Callao! (Yale Mus.). Valparaiso! (Lütken).

Stichaster aurantiacus V. (Meyen sp.), Callao! Valparaiso (Gray), Chili (M. and Tr.).

Heliaster helianthus Gray, Paita and Callao! Caldera, Chili! Valparaiso.

H. Cumingii Gray, Paita and Zorritos!

ECHINOIDEA.

Echinocidaris stellata Ag., Paita and northward!

E. spatuligera Ag., Paita and Callao! Coquimbo (Ag. and Des.).

Arbacia nigra Gray, Paita and Callao to Caldera, Chili! Coquimbo.

(?) *A. grandinosa* (Val. sp.), Peru, Carthagenia, (Ag. and Des.).

Loxechinus albus Ag. and Des., Mejillones! Callao to Chili (Ag. and Des.).

Euryechinus imbecillis Verrill, Paita and Callao!

Boletia viridis Verrill, Callao!*

Agassizina scrobiculata Val., Peru (Ag. and Des.).

* Probably from New Zealand, see footnote, p. 304,—Reprint.

HOLOTHURIOIDEA.

Anaperus Peruanus Trosch., Païta and Callao !(=*Pattalus Peruvianus* V.).
Pentacta sp., Païta !

In this list are 18 species, of which only 3 have been recorded from north of Cape Blanco, and two of these apparently find their southern limit at Païta ; 2 are known only from Païta, and 2 from Callao. Six of the species extend southward to northern Chili, and several even to Valparaíso.

List of species from the coast of Chili.

OPHIURIOIDEA.

Astrophyton Chilense Phil., Chili.
Ophiolepis Atacamensis Phil., Isla Blanca, Chili.
Ophiactis asperula Lütke., Chili, Isle of Philoe.
Amphiura Chilensis Lütke., Chili.

ASTERIOIDEA.

Goniodiscus verrucosus Phil., Chili, Valparaíso and Rio Maipo.
G. singularis Müll. and Tr., Chili.
Astrogonium Fonki Phil., Chili.
Asteriscus (Patiria) Chilensis Lütke., Valparaíso and northward !
Heliaster helianthus Gray, Valparaíso and northward.
Stichaster auranticus V. (Meyen sp.), Valparaíso and northward.
Asterias gelatinosa Meyen (*A. rustica* Gray), Valparaíso.
Asterias echinata Gray, Valparaíso. Perhaps identical with one of the following.
Asterias Germanii nobis (Philippi sp.), Chili.
Asterias lurida nobis (Philippi sp.), Chili.

ECHINOIDEA.

Echinocidaris spatuligera Ag. and Des., Coquimbo and northward.
Arbacia nigra Gray, Coquimbo and northward.
Loxechinus albus Ag. and Des., Chili northward to Callao.
Anthocidaris erythrogramma (Val. sp.) Lütke., Chili, Ag. and Des.
Colobocentrotus pediferus Ag., Valparaíso !

Of the 19 species in this list, 6 occur also on the coast of Peru, at Callao or farther north. The remaining species are peculiar to the district so far as known. It is probable that northern Chili, perhaps as far as Valparaíso, belongs to the Peruvian Fauna, while the shores of southern Chili, and Patagonia, are inhabited by a distinct Fauna. The absence of exact localities for many of the species prevents a satisfactory solution of this question.

List of species from the Southern extremity of South America, and the neighboring Islands.

ASTERIOIDEA.

Ganeria Falklandica Gray, Falkland Islands.

Asterias antarctica (Lützk. sp.), Straits of Magellan.

Asterias rugispina Stimp., Orange Harbor, Terra del Fuego.

ECHINOIDEA.

Echinocardis Scythei Phil., Straits of Magellan.

Echinus Magellanicus Phil., Straits of Magellan.

Abatus australis (Phil. sp.) Trosch., South America, Statten Land.

A. cavernosus (Phil. sp.) Trosch., Statten Land.

A. antarcticus (Gray sp.) Lützk., South Polar Seas.

Tripylus excavatus Phil., Southern extremity of South America.

(?) *T. Philippii* Gray, South America.

HOLOTHURIOIDEA.

Lepidopsolus? antarcticus (*Cuvieria antarctica* Phil.), Straits of Magellan.

An analysis of the preceding lists shows that the distribution of Echinoderms on the West coast of America agrees very nearly with that of the Crustacea, as determined by Prof. Dana;* with that of Mollusca, as elucidated by Carpenter;† and with the general facts determined for the Fishes, Mollusca and Radiata by Forbes.‡ But at the same time there are some disagreements in subordinate points which demand attention, and additional evidences are obtained concerning the actual limits of the several faunæ.

The comparatively small number of species of Echinoderms and the definiteness of their characters, except among Holothurians, renders this class well adapted to illustrate the faunal divisions, while the localities for the species described from these coasts are generally more authentic than in many other regions.

The faunal divisions, indicated by the information already in our possession, are as follows:

THE SITCHIAN PROVINCE.—This fauna was believed by Forbes to extend southward to Oregon, including Puget Sound, while by Dana the latter region was named as a distinct region, the Pugettian Province. The Echinoderms now known indicate that in this class Puget Sound agrees nearly with the fauna of Oregon. The limits of the Sitchian fauna are not yet known. To the north it appears to pass into the Arctic, or Circumpolar Fauna, while several of the arctic

* Report upon the Crustacea of the U. S. Expl. Exp., by J. D. Dana, 1852.

† Report of the British Association, 1856.

‡ Johnston's Physical Atlas, p. 99, Pl. 31, 1856.

species have a range even southward of this fauna to the coast of Oregon. It apparently corresponds to the Syrtensian Fauna of Packard,* on the Atlantic coast of America.

THE OREGONIAN PROVINCE.—This division includes Puget Sound, in part at least, and the Coast of Oregon, extending to Cape Mendocino, Cal. It appears to be the western representative of the Acadian Fauna on the northeast coast of America. This is not equivalent to the Oregonian Province of Forbes, which extended from Columbia River to San Diego, including, therefore, this and the following.

THE CALIFORNIAN PROVINCE.—This occupies the coast from Cape Mendocino to Santa Barbara, and perhaps farther southward, and includes the Santa Barbara Islands, corresponding therefore with the limits assigned by Dana, while later this name was applied by Forbes to the fauna occupying the coast of the peninsula of Lower California.

It appears to represent the Virginian Fauna of the Atlantic coast. Many species are common to this and the Oregonian, while a large per cent, so far as now known, are peculiar to each. Numerous representatives of the genus *Asterias* give a peculiar character to both; and the genus *Dendraster* is not known elsewhere, except in the Sitichian Fauna. *Loxechinus purpuratus* and *Toxopneustes Franciscana* are peculiar and characteristic species of the Californian Province.

The Diego, and the Sonora Provinces, indicated by Prof. Dana, are almost unexplored for their Echinoderms. The former extends, according to Dana, from latitude $28\frac{1}{2}^{\circ}$ to $34\frac{1}{2}^{\circ}$, and the latter occupies the coast southward along the peninsula of Lower California, nearly to Margarita Bay. It is probable that some of the species described as from "California" belong to this almost unexplored region.

THE PANAMANIAN PROVINCE.—This includes the Gulf of California, and on the coast extends from Margarita Bay, Cal., to Cape Blanco, Peru. It corresponds with Dana's Tropical Sub-kingdom and includes three subdivisions: The Mexican District or Province, including the Gulf of California, Cape St. Lucas, and the Mexican coast to Acapulco or beyond; the Panama District, including the coast of Central America and the Bay of Panama; the Ecuador District, occupying the coast southward from Panama Bay to Cape Blanco, Peru. These correspond nearly with those given by Dana, who considered them three distinct Provinces. Concerning the northern limit of this fauna there has been a pretty close agreement. Its southern limit, however, has not been so well established. Forbes included the coast only to Guayaquil, while

* Memoirs Boston Society of Natural History, vol. i, page 254; and Proceedings B. S. N. H., 1866, p. 333.

Dana placed the boundary farther south, at Cape Blanco. Mr. Bradley's collection made at Zorritos, a short distance north of Cape Blanco near Tumbes, shows a remarkable agreement with the fauna of Panama, not only in the Echinoderms, but also in all other classes, and especially in the Mollusca, Polyps, and Crustacea, while his Paita collection shows quite as remarkable an agreement with the Peruvian Fauna. There is thus a very abrupt change in the faunæ between Zorritos and Paita, and Cape Blanco may properly be considered as the point of division.

The large proportion of species that have a range throughout the whole extent of this Fauna, induces me to consider the three subdivisions proposed by Dana, as of secondary importance, yet in the present state of our knowledge there are several species peculiar to each of these subdivisions. The number, however, has been materially reduced by the late explorations.

THE GALAPAGOS PROVINCE.—It is somewhat uncertain whether this should not be united to the preceding, as a district or sub-province, many of the species being characteristic Panamian forms. At the same time some Peruvian species occur, which even caused both Dana and Forbes to unite this Fauna with that of Peru. Possibly the southern part of the Islands belong rather to the Peruvian and the northern to the Panamian Fauna. The recorded localities are not sufficiently exact to determine this question.

The large percentage of species peculiar to this region and belonging in most cases to Pacific rather than American types has induced me to consider it a distinct fauna, with an intermixture of Peruvian and, especially, Panamian forms.

THE PERUVIAN PROVINCE.—The region from Cape Blanco southward to northern Chili is inhabited by a very distinct and characteristic Fauna. One species only (*Echinocidaris stellata*) has been found in this Province, and that only in the extreme northern portion, which occurs also at Panama. The northern limit is well marked, but the southern is not yet accurately known. It appears to extend as far, at least, as Coquimbo, while even at Valparaiso many of the characteristic species occur. Dana considered Copiapo to be near its southern limit.

THE CHILIAN PROVINCE.—The middle coast of Chili, from near Coquimbo to Valdiva, appears to be inhabited by a peculiar Fauna, although at the same time several of the Peruvian species are mingled with those characteristic of this region. By Forbes the Peruvian Fauna was joined directly to the Araucanian.

THE ARAUCANIAN PROVINCE.—This appears to extend from near Valdiva to the south-western coast of Patagonia, but its southern portion is very little known. Dana places its southern boundary at lat. 50°, which would make its length about 900 miles.

THE FUEGIAN PROVINCE.—This includes southern Patagonia and the adjacent Islands. Several peculiar and interesting Echinoderms have been described from this Fauna, some of which, as *Asterias antarctica* and "*Cuvieria antarctica*," recall the forms of the Arctic regions, while there are other genera, as *Tripylus*, that are quite peculiar.

Comparison of the Tropical Echinoderm Faunæ of the East and West Coasts of America.

The question of identity between certain species found upon the Atlantic and Pacific coasts of Central America is of great interest both to the Zoölogist and Geologist, and has received much attention from various writers. That the two Faunæ are remarkably similar in many respects, and have large numbers of closely allied, representative or analogous species, is admitted by all who have written upon the subject. Several authors also admit a certain number of species which are identical or undistinguishable. Thus of Mollusca, Dr. P. P. Carpenter* admits 35 species as identical between the two coasts; 34 additional ones that may prove to be identical; 41 that are "really separated, but by slight differences;" 26 that are "analogous but quite distinct species." In addition to these he admits 15 species as probably common to the west coast of America and the west and south coasts of Africa. Prof. C. B. Adams† did not admit any species as common to Panama and the West Indies, except *Crepidula unguiformis*.

Prof. Dana, Dr. Stimpson,‡ and others admit several species of Crustacea as common to the two coasts. In the collections of Mr.

* Report of the British Association for the advancement of Science, 1856.

† Annals of the Lyceum of Natural History of New York, v, 1852.

‡ Notes on North American Crustacea. Annals Lyceum Nat. Hist. of N. Y., 1858 and 1860. In these papers the following species are indicated from both coasts:

<i>Petrolisthes armatus</i> Stimp.	<i>Cronius ruber</i> Stimp.
<i>Ozius perlatus</i> Stimp.	<i>Nautilograpsus minutus</i> M. Edw.
<i>Eriphia gonagra</i> M. Edw.	<i>Acanthopus planissimus</i> Dana.
<i>Callinectes diacanthus</i> Stimp.	<i>Domecia hispida</i> Souly.

Mr. Albert Ordway has satisfactorily separated the western species of *Callinectes* from those of the West Indies, (Boston Journal Nat. History, vol. vii, 1863). Concerning some of the other species Dr. Stimpson, himself, expresses doubt, owing to the want of sufficient specimens for ascertaining the constancy of slight differences.

Bradley there is a species of *Eriphia** from Panama that appears to be undistinguishable from specimens collected at Aspinwall, but many allied species, which are clearly distinct, occur on the opposite coasts.

Of Fishes, Prof. Theodore Gill† and Mr. F. W. Putnam both admit one species, at least, that appears to be common to both coasts, or in which no characters have as yet been found by which to separate them. The Fishes as a rule are nearly allied and many analogous or representative species occur.‡

The Polyyps, as we have shown in a former paper,§ are entirely distinct, many of the genera and families being peculiar to each coast. The Panamanian Fauna includes *Pavonia*, *Pocillipora*, *Ulangia*, *Cenopsammia*, genera which are peculiar to the Pacific and Indian Oceans, while a few of the peculiarly American or Atlantic genera are represented by analogous species, as *Renilla*, *Phyllangia*, etc., but most of the characteristic West Indian genera and families are entirely absent. Several peculiar genera also occur, as *Stylatula* and *Stephanaria*.|| The genera *Muricea*, *Gorgonia* (*Rhipidogorgia*),¶ *Asstrangia*, are represented by more species in the Panamanian Fauna than elsewhere, but have analogous species in the Caribbean Fauna.

In the following list all the known Echinoderms of the Atlantic and Pacific Tropical American coasts are placed side by side, in order to show the similarity of the two faunæ, as well as their remarkable distinctness. When special localities are not given for a Caribbean species, it is to be regarded as inhabiting the West Indian Islands, most frequently the Antilles. A mark of exclamation (!) has been added after the names of those species that I have personally studied, as well as after localities from which I have had specimens for examination. For the Panamanian species I have in most cases omitted special localities, because they have been given in the preceding lists, but have added remarks upon their stations, etc., derived from the notes of Mr. Bradley. (Localities introduced in the Reprint are in italics.)

* This proves to be distinct. It is the *Eriphia squamata* St. *E. gonagra* has not been confirmed from Panama,—Reprint.

† Proceedings Philadelphia Academy Nat. Sciences, vol. xiv, p. 249, 1862. (*Brachyrhinus ereolus* Gill).

‡ Dr. Günther regards 78 out of 303 species of Central American fishes as identical on the opposite coasts. Of these 173 are truly marine species with 57 identical,—Reprint.

§ Proceedings Boston Soc. Nat. History, x, p. 323, 1866.

|| This name is proposed instead of *Stephanocora*, which was previously used by Ehrenberg in 1834 for a genus of *Oculinidae*.

¶ We have since ascertained that these species are generically distinct from the West Indian "*Rhipidogorgia flabellum*," and belong to *Leptogorgia* and *Eugorgia*,—Reprint.

CARIBBEAN FAUNA.

PANAMIAN FAUNA.

Crinoidea.*

- Pentacrinus asterias* (Linn. sp.)
*P. Müller*i Örsted (P. caput-medusæ Müll.).
 (?) *P. decora* Thomson.
Antedon Dubenii Bolsche. Rio Janeiro.
A. Braziliensis Ltk. Rio Janeiro. !
 (?) *A. Milbertii* Müll. North America.

None known.

Other described species probably occur in the West Indies, but the lack of authentic localities prevents their admission here.

Ophiuroidea.†

FAMILY, ASTROPHYTIDÆ.

- Astrophyton muricatum* Ltk. !
 Charleston, Bahamas, Florida! St. Croix.
A. cæcilia Ltk. St. Croix, on *Thesoa* !
A. Krebsii Ltk. St. John (Ltk.)

Astrophyton Panamense Verrill !
 Panama! Zorritos, Peru, at 4 fathoms depth, clinging to *Muricea*! *La Paz*!

FAMILY, ASTROCHEMIDÆ.

- Asteropora annulata* Örs. and Ltk.
A. affinis Ltk.
A. dasycladia Duj. and H.
Astrochema oligactes Ltk.
 St. Johns, 20 fathoms.
A. affinis Duj. and H.

FAMILY, OPHIOMYXIDÆ.

- Ophiomyxa flaccida* Ltk. !
 Florida to St. Thomas.

Ophiomyxa sp.

FAMILY, OPHIOCOMIDÆ.†

- Ophiocomu echinata* Ag. ! Florida !
 Aspinwall ! St. Thomas and Cumana.
O. Riisei Ltk. ! Florida ! Aspinwall !
 St. Thomas and Cumana.
O. pumila Ltk. ! Bahamas ! Florida !
 Aspinwall ! and St. Thomas.
Ophiopsila Riisei Ltk. !
Ophiactis Krebsii Ltk. !
 Bahamas ! Florida, Charleston, St. Thomas.
O. Mulleri Ltk. !
 Florida to St. Thomas.

Ophiocomu æthiops Ltk. !
 Low-water to quarter tide, under stones and in crevices.
O. Alexandri Lym. !
 Low-water, in crevices of the reef at Panama.
Ophiactis Örstedii Ltk.
O. arenosa Ltk.
O. virescens Örs. and Ltk. !
O. simplex Ltk. !
Amphiura geminata Ltk. !
A. violacea Ltk. !
A. Örstedii Ltk.

- Amphiura Riisei* Ltk.
A. Stimpsonii Ltk.
A. tenera Ltk. Charleston, St. Thomas.

* *Antedon Hagenii* Pourt., *A. meridionalis* (Ag. sp.) Verrill, *A. armata* Pourt., *A. cubensis* P., *A. rubiginosa* P., *A. berrypinna* P., and *Rhizocrinus lofotensis* Sars are additional species from the deep sea explorations of Pourtales,—Reprint.

† *Amphipholis albida* Ljung, and *A. subtilis* Lj., Rio Janeiro; *A. Januarii* Lj., Brazil; *Ophioneurhys limicola* Ltk. and *Ophionema intricata* Ltk., St. Thomas; *Ophiacantha Pentacrinus* Ltk., Antilles, have since been described. See also Mr. Lyman's descriptions of 7 new genera and 21 new species from the deep sea collections of Pourtales off Florida, in Bulletin Mus. Comp. Zoöl., p. 316, 1869,—Reprint.

CARIBBEAN FAUNA.

- A. limbata* Ltk. Rio Janeiro.
A. gracillima Stimp. !
Ophiophragmus septus (Ltk. sp.) Lym.
O. Wurdemanni Lym.
 Charlotte's Harbor, Florida.
Ophiocnida scabriuscula Lym.
Hemipholis cordifera Lym. Carolina !
Ophioblenna Antillensis Ltk.
Ophiostigma isocanthum Ltk.
 Florida, St. Thomas, St. John.
Ophionereis reticulata Ltk. ! Bermuda !
 Florida ! Bahamas ! St. Thomas, Cumana.
 (?) *O. porrecta* Lym. †
 Florida (?) (Lym.)
Ophiothrix violacea M. and Tr. † !
 Florida, Aspinwall ! West Indies ! and
 Brazil !
O. Örstedii Ltk. !
 Bahamas ! Florida, St. Thomas, Cumana.
O. Suensonii Ltk. !
 St. Thomas ! Carthage, N. G.
O. lineata Lym. !
 Aspinwall ! Florida (Lym.).

PANAMIAN FAUNA.

- A. microdiscus* Ltk.
A. Puntarenæ Ltk. *
Ophiophragmus marginatus Lym.

Ophiocnida hispida Lym. !
Hemipholis gracilis Verrill !

Ophionereis annulata Lym. !
O. Xantusi Lym.

Ophiothrix spiculata LeC. !

O. dumosa Lym.

Ophiethela mirabilis Verrill !
 Panama to La Paz !

FAMILY, OPHIOLEPIDÆ.

- Ophiolepis elegans* Ltk.
 Florida, Charleston, S. C. (Lym.)
O. paucispina M. and Tr. !
 Florida to St. Thomas.
Ophioceramias Januarii Lym.
 Rio Janeiro.
Ophiozona impressa Lym.
 Florida to St. Thomas.
- Ophiolepis variegata* Ltk. !

Ophiozona Pacifica Lym. !

FAMILY, OPHIURIDÆ.

- Ophiura cinerea* Lyman !
 Florida ! Aspinwall ! St. Thomas.
O. appressa Say ! Florida ! Aspinwall !
 St. Thomas and Cumana.
O. rubicunda Lym. !
 Aspinwall ! Florida ! to St. Thomas.
O. squamosissima (Ltk. sp.) Lym.
O. elaps (Ltk.) Lym. Bahamas !
O. brevicauda Lyman !
 Florida ! Aspinwall ! St. Thomas.
O. guttata (Ltk. sp.) Lyman.
O. brevispina Say !
 Florida and Bahamas to St. Thomas.
O. Januarii Lym. Rio Janeiro !
- Ophiura teres* Lym. !
O. Panamensis Lym. !
O. sp. nov. !

O. variegata Lym. !

O. Daniana Verrill !

* *Amphipholis grisea* Ljung., Guayaquil, is an additional species,—Reprint.

† This species proves to be from the Hawaiian Islands,—Reprint.

‡ Dr. Lütken has separated the West Indian from the Brazilian form under the name of *O. Caribæa*,—Reprint.

CARIBBEAN FAUNA.

PANAMIAN FAUNA.

Asterioidea.*

FAMILY, ASTROPECTENIDÆ.

<i>Luidia clathrata</i> (Say sp.) Ltk.!	<i>Luida tessellata</i> Ltk.!
S. Carolina! Florida! St. Thomas (Ltk.).	
<i>L. alternata</i> (Say sp.) Ltk.	<i>L. Bellonæ</i> Ltk.!
Florida (Say), St. Thomas (Ltk.).	
<i>L. Macgravii</i> Stp. Brazil!	(?) <i>L. (Petalaster) Columbia</i> (Gray sp.).
Jamaica (Browne), Cotinguiba.	
<i>Astropecten articulatus</i> (Say sp.) Ltk.!	<i>Astropecten regalis</i> Gray!
E. Florida and Georgia (Say).	
(?) <i>A. ciliatus</i> Grubé.	<i>A. fragilis</i> Verrill!
Porto Cabello (Grubé).	
<i>A. variabilis</i> Ltk.!	<i>A. Örstedii</i> Ltk.!
Florida! St. Thomas (Ltk.).	
<i>A. Antillensis</i> Ltk.!	(?) <i>A. armatus</i> Gray.
St. Thomas.	
(?) <i>A. Valenciennesii</i> M. and Tr.	(?) <i>A. erinaceus</i> Gray.
Vera Cruz.	
(?) <i>A. Braziliensis</i> M. and Tr. Brazil.	
(?) <i>A. dubius</i> Gray.	

FAMILY, GONIASTERIDÆ.

<i>Oreaster gigas</i> (Linn.) Ltk., = <i>O. reticulatus</i> M. and Tr.	<i>Oreaster occidentalis</i> Verrill!
Florida! Hayti! St. Thomas (Ltk.), Curacao, Barbados, Abrolhos, Brazil!	Panama to La Paz!
(?) <i>O. aculeatus</i> M. and Tr.	(?) <i>O. Cumingii</i> Gray sp.
Probably the same as the preceding.	
	<i>Didorellia armata</i> Gray!
	(?) <i>Goniodiscus stella</i> Verrill!
	Perhaps young of the preceding.†
	<i>Paulia horrida</i> Gray.
	<i>Gymnasteria inermis</i> Gray.
	<i>G. spinosa</i> Gray. La Paz!
<i>A. stellifer</i> Mob. (<i>A. Braziliensis</i> Ltk.)	<i>Patiria obtusa</i> Gray!
Rio Janeiro.	
<i>Asteriscus folium</i> Ltk.!	<i>Asteriscus modestus</i> Verrill!
Aspinwall! St. Thomas (Ltk.).	Under stones at low-water mark.

FAMILY, ECHINASTERIDÆ.‡

<i>Echinaster spinosus</i> M. and Tr.	(?) <i>Acanthaster Ellisii</i> (Gray) La Paz!
Florida! Hayti! St. Thomas (Ltk.).	<i>Echinaster aculeatus</i> (Gray.)
<i>E. Braziliensis</i> M. and Tr.	
Puerto Cabello, Jamaica, Rio Janeiro.	
<i>E. serpentarius</i> M. and Tr. Vera Cruz.	<i>Mithrodia Bradleyi</i> Verrill! La Paz!
	<i>Ferdina Cumingii</i> Gray.

* Mr. Pourtales has dredged *Pteraster militaris* off Florida in 120 to 125 fathoms,—Reprint.

† This proves to be the case, (see page 372),—Reprint.

‡ *Echinaster crassispina* V., Abrolhos Reefs and *E. spinulosus* V., West Florida, are additional species,—Reprint.

CARIBBEAN FAUNA.

PANAMIAN FAUNA.

FAMILY, OPHIDIASTERIDÆ.

- | | |
|--|--------------------------------------|
| (?) <i>Linckia Guildingii</i> Gray. | <i>Linckia Columbiæ</i> Gray. |
| <i>L. ornithopus</i> Ltk. | <i>L. unifascialis</i> Gray! |
| St. Thomas, etc. (Ltk.), Vera Cruz (M. and Tr.). Probably identical with the last. | <i>Cistina Columbiæ</i> Gray. |
| | <i>Dactylosaster gracilis</i> Gray. |
| <i>Ophidiaster flaccidus</i> Ltk. | <i>Ophidiaster pyramidatus</i> Gray! |
| St. Thomas (Ltk.). | |

FAMILY, ASTERIDÆ.

- | | |
|--|---------------------------------------|
| <i>Asterias Mexicana</i> (Ltk. sp.) Verrill. | <i>Asterias sertulifera</i> Xantus. |
| (?) <i>A. tenuispina</i> Lam.* | <i>Heliaster microbrachia</i> Xantus! |
| Bermuda! | <i>H. Kubiniji</i> Xantus! |
| | <i>H. Cumingii</i> Gray! |

Echinoidea.†

FAMILY, CIDARIDÆ.

- | | |
|---|------------------------------------|
| <i>Cidaris annulata</i> Gray! | <i>Cidaris Thouarsii</i> Val.! |
| Florida! Aspinwall! Rio Janeiro (Ltk.). | Cape St. Lucas, Panama! Galapagos! |

FAMILY, DIADEMIDÆ.

- | | |
|-------------------------------------|---|
| <i>Diadema Antillarum</i> Mich.! | <i>Diadema Mexicana</i> A. Ag.! |
| Florida! Aspinwall! Hayti! Bahamas! | <i>Echinodiadema coronata</i> Verrill! |
| Antilles and Surinam (Ltk.). | <i>Astropyga venusta</i> Verrill! La Paz! |

FAMILY, ARBACIDÆ.

- | | |
|--|---------------------------------------|
| <i>Echinocidaris punctulata</i> Desml.! | <i>Echinocidaris stellata</i> Ag.! |
| S. Carolina to W. Indies. | Guayamas to Paita! Galapagos Islands. |
| (?) <i>E. Dufrenoyi</i> Desml.† | |
| Cumana (Ag. and Des.). | |
| (?) <i>Arbacia pustulosa</i> (Lam. sp.). | |
| Brazil (Ag. and Des.). | |

FAMILY, ECHINIDÆ.

- | | |
|--|-------------------------------------|
| <i>Lytechinus variegatus</i> A. Ag.! | <i>Lytechinus roseus</i> Verrill! |
| Yucatan to Bahia (Ltk.), Hayti! Florida! | Acapulco to Panama! |
| <i>L. Atlanticus</i> A. Ag. (? <i>L. excavatus</i>) | |
| Bl sp.) Bermuda! | |
| (?) <i>Psammechinus aciculatus</i> Hupé. | <i>Psammechinus pictus</i> Verrill! |
| Brazil. | |

* Since described under the name, *Asterias Atlantica* Verrill, from Brazil, Cuba, and Bermuda,—Reprint.

† Mr. A. Agassiz records 19 additional species, including 9 new genera and 14 new species, from the deep-sea collections of Pourtales, in Bulletin M. C. Z., No. 9,—Reprint.

‡ The Essex Institute, Salem, Mass., has two specimens, beautifully variegated with green, and agreeing entirely with the description of this species. One is labelled as coming from the "West Coast of Africa," the other from the "Sandwich Islands." The former locality is most likely to prove to be the true one.

CARIBBEAN FAUNA.

PANAMIAN FAUNA.

FAMILY, ECHINOMETRIDÆ.

<i>Echinometra Michelinii</i> Des. (<i>E. lucuntur</i> , pars, auth.)!	<i>Echinometra Van Brunti</i> A. Ag.!
Florida! Aspinwall! Hayti! Brazil!	Acapulco, Cape St. Lucas, and La Paz!
<i>E. viridis</i> A. Ag. (<i>E. Michelinii</i> Ltk.)!	<i>E. rupicola</i> A. Ag.!
Florida! Aspinwall! Antilles (Ltk.).	Acajutla to Zorritos.
<i>E. plana</i> A. Ag. Hayti.	
(?) <i>Anthocidaris Mexicana</i> (Ag. sp.)*	<i>Toxopneustes</i> sp. (<i>Toxocidaris Mexicana</i> A. Ag.), Acapulco.
Vera Cruz (Ag. and Des.)	

FAMILY, HIPPOCIDÆ.

<i>Tripaneustes ventricosus</i> Ag.!	<i>Tripaneustes depressus</i> A. Ag.
Florida! Yucatan to Surinam (Ltk.).	Guayamas, La Paz!

FAMILY, CLYPEASTERIDÆ.†

<i>Clypeaster rosaceus</i> Lamk.	<i>Clypeaster speciosus</i> Verrill!
Florida to Antilles (Ltk.).	La Paz!
<i>Stoloniclypeus prostratus</i> A. Ag.!	<i>Stoloniclypeus rotundus</i> A. Ag.!

FAMILY, SCUTELLIDÆ.‡

<i>Mellita hexapora</i> Ag.!	<i>Mellita Pacifica</i> Verrill!
Florida! Mexico, Barbados, Surinam (Ltk.).	
<i>M. pentapora</i> Ltk.!	<i>M. longifissa</i> Mich.
W. Indies, Cumana, Brazil.	Panama (A. Ag.), La Paz!
(?) <i>M. testudinea</i> Klein!	
N. Carolina! Florida! Texas!	
<i>Encope emarginata</i> Ag.!	<i>Echinoglycus Stokesii</i> Gray!
Florida! to Rio Janeiro.	<i>Encope occidentalis</i> Verrill!
(?) <i>E. quinqueloba</i> (Esch. sp.) Grubé!	<i>E. grandis</i> Ag.!
Florida! to Brazil.	Gulf of California, La Paz!
<i>E. Michelinii</i> Ag.!	<i>E. Californica</i> Verrill!
<i>Moulinia cassidulina</i> Ag. Martinique.	La Paz!

FAMILY, CASSIDULIDÆ.

<i>Echinoneus semilunaris</i> Lamk.!	
Cuba to Trinidad (Ltk.).	
<i>Cassidulus Caribæarum</i> Lamk.	<i>Pygorhynchus Pacificus</i> Ag.!
Jamaica, etc., St. Thomas (Ltk.).	

FAMILY, SPATANGIDÆ.

<i>Brissus columbaris</i> Ag. and Des.!	<i>Brissus obesus</i> Verrill!
Florida! Antilles (Ltk.).	
<i>Meoma ventricosa</i> Ltk.	<i>Meoma nigra</i> Verrill!
Honduras, Antilles (Ltk.).	
<i>Plagiorotus pectoralis</i> Ag. and Des.!	<i>Metalia nobilis</i> Verrill!
Mexico, Antilles, Bahia, Turks Island!	

* Mr. A. Agassiz considers this his *Echinometra plana*.—Reprint.† *Clypeaster speciosus* V., from La Paz, is an additional species.—Reprint.‡ *Encope Californica* V., from La Paz, is here added.—Reprint.

CARIBBEAN FAUNA.

Agassizia excentrica A. Ag. Florida.**Mæra atropos* Mich.

N. Carolina! Texas! Antilles (Ltk.).

PANAMIAN FAUNA.

Agassizia ovulum Ltk.!*Mæra clotho* Mich. (A. Ag.).*Lovenia* sp. Gulf of California.**Holothurioidæ.†**

FAMILY, SYNAPTIDÆ.

Synapta lappa Müll.*Leptosynapta hydriformis* nob.† (LeS.)

Guadeloupe.

L. Pourtalesii Selenka (S. viridis

Pourt, non LeS.).

Biscayne Bay, Florida. Perhaps the same as the last.

Heterosynapta viridis nob.§ (LeS. sp.)*Synaptula vivipara* Örst.*Chirodota pygmaeum* Müll.*C. rotiferum* (Pourt. sp.) Stimp.

Biscayne Bay, Florida, (Pourt.)

FAMILY, CUCUMARIDÆ.

Phyllophorus (?) *lepadifera* V. (Hol-*othuria lepadifera* LeS.).

St. Bartholomew.

Stolus ovulum Selenka. Acapulco.*Stolus gibber* Sel. Panama.*Urodemas* sp. nov. Bahamas!*Pentacta Panamensis* Verrill!*Lissothuria ornata* Verrill!

FAMILY, HOLOTHURIDÆ.

Holothuria botellus Sel

Tortugas, Florida, etc.

H. princeps Sel. Florida, *Egmont Key*!*H. maculata* LeS. St. Bartholomew.*H. unicolor* Sel. Barbadoes.*H. glaberrima* Sel.

"Hayti, Bahama Is., Panama."

H. grisea Sel. Hayti.*H. Floridiana* Pourt.

"Florida, Zanzibar, Sandwich Is., Java,"

&c., (Sel.).

Holothuria botellus Sel.

"Panama, Sandwich Is., Zanzibar, Florida."

H. languens Sel. Panama.*H. subditiva* Sel. Panama (Florida?)*H. lubrica* Sel. Acapulco.*H. glaberrima* Sel.

Panama, Hayti, etc.

* This species, from the dredgings of Pourtales, and *Mæra clotho* are introduced on the authority of Mr. A. Agassiz,—Reprint.

† Mr. Pourtales reports *Cuvieria* (?) *Lepidopsolus operculata* (Pourt.), *Thyonidium conchilegum* P., *T. gemmatum* P., *Echinocucumis typica* Sars, *Cucumaria frondosa* Gunner, and *Molpadia borealis* Sars from his deep-sea collections,—Reprint.

‡ See note page 325 for the genus *Leptosynapta*.

§ The name *Heterosynapta* is here proposed for a new genus having *H. viridis* LeS. sp. as its type. It is remarkable in having four simple and eight pinnate tentacles. Its skin contains small calcareous hooks, as in *Leptosynapta*. It has the habit of clinging to algæ, etc., instead of burrowing like most others of this family.

CARIBBEAN FAUNA.

- Stichopus rigidus* Sel.
Florida, Zanzibar, etc.
S. badionotus Sel.
"Florida (Acapulco?)"
Actinopyga (Mulleria) parvula (Sel.sp.)
Florida.
A. (M.) Agassizii (Sel. sp.)
Florida, Tortugas, Hayti.
A. (M.) obscura (LeS. sp.)
St. Bartholomew. This and the next two
species may prove identical with some of
the preceding.
Bohadschia agglutinata (LeS. sp.)
St. Bartholomew.
B. fasciata (LeS. sp.)
St. Bartholomew.
Sporadipus gigas Örst. !
Perhaps identical with one of the preced-
ing species.

PANAMIAN FAUNA.

- Stichopus Kefersteinii* Sel.
Acapulco.

These lists contain 125 species from the Caribbean, including a few that are marked as doubtful, and 82 from the Panamian Fauna. Of these none have ever been indicated as common to the two coasts, except two species of Holothurians which Selenka records from both coasts, and another (*Stichopus badionotus* Sel.) from Florida and, doubtfully, from Acapulco. The Holothurians being very difficult to identify with alcoholic specimens, it is not improbable that these few apparent exceptions to the rule among the Echinoderms will prove to be errors in determining the species. In the other orders the species are often very closely allied in structure and appearance, yet the differences are in all cases sufficiently apparent. There are, however, so many analogous or representative species in the two faunæ, and so general an agreement in the genera and families represented, that the general features of the faunæ have a remarkable similarity, while they stand in strong contrast with the tropical fauna of the Pacific and Indian Oceans.

In this respect the Echinoderms agree with the observations, previously made upon the Crustacea and Mollusca, and confirm the statement that both coasts of America belong to one grand Zoölogical Realm, in distinction from all other regions, and that America has therefore a remarkable insular character, and may be regarded zoölogically as a great "Island in the Atlantic Ocean," the deep oceanic basin west of the Galapagos limiting the western extension of the American or Atlantic forms.

Among the types peculiar to the American Realm the genus *Ophiura* is one of the most remarkable instances, since it abounds on both

sides of America, being represented by numerous species. But with the exception of one Mediterranean species, the genus is unknown elsewhere, no representatives of it having been discovered in the Indian or Pacific Oceans, where it appears to be replaced by *Ophiopoeza*, *Ophiarachna*, etc., which have a similar appearance, but with only ten ovarial openings, instead of twenty. Among other genera, occurring on both coasts of America, but unknown in the great Indo-Pacific Fauna, are the following: *Ophiozona*, *Ophiostigma*, *Hemipholis*, *Ophiophragmus*, *Ophiomyxa*, *Lytechinus*, *Encope*, etc. The following, although represented in other regions, appear to have their greatest development upon the American coasts: *Ophiactis*, *Amphiura*, *Echinaster*, *Luidia*, *Echinocidaris*, *Arbacia*, *Mellita*.

Several genera, which occur in the West Indies and appear to be peculiar to the Atlantic, or have there their greatest development, have not yet been found in the Panamanian Province. Such are, *Pentacrinus*, *Ophioblennia*, *Asteroporpa*, *Asterochema*, *Clypeaster* (also Pacific), *Cassidulus*, *Plagionotus*, *Mæra*.*

A few genera are found in the Panamanian Fauna, which occur also in the Indo-Pacific, but have not been met with in the Caribbean Fauna. Among these are the following: *Ophiothela*, *Mithrodia*, *Acanthaster*, *Astropyga*, *Metalia*, *Lovenia*. The following genera seem at present peculiar to the Pacific coasts of America: *Nidorellia*, *Gymnasteria*, *Heliaster*, *Echinodiadema*, *Echinoglycus* (restricted), *Pygorhynchus* (also fossil in Europe), *Agassizia*; and in the temperate regions, *Pycnopodia*, *Loxechinus*, *Dendraster*.†

There are, also, numerous species in each Fauna belonging to cosmopolitan genera, or to genera found in all tropical seas, but none of these species, excepting the doubtful Holothurians, are common to both coasts, or to the Panamanian and Indo-Pacific Faunæ, or to the latter and the Caribbean. Among cosmopolitan genera, represented on each coast, are: *Ophiolepis*, *Ophiocoma*, *Amphiura*, *Ophiactis*, *Ophionereis*, *Ophiothrix*, *Astrophyton*, *Astropecten*, *Luidia*, *Asteriscus*, *Oreaster*, *Ophidiaster*, *Linckia*, *Cidaris*, *Diadema*, *Psammochinus*, *Echinometra*, *Toxopneustes*, *Stoloniclypeus*, *Brissus*, *Meoma*.

From the preceding analysis of the genera, it is evident that while the Panamanian Fauna has several truly Indo-Pacific types, and some that are peculiar, it is nevertheless most closely related to the Carib-

* *Clypeaster speciosus* V., and *Mæra clotho* Mich., are now known from the west coast; *Cassidulus* is now regarded by A. Agassiz as the same genus with *Pygorhynchus Pacificus*, and he refers *Metalia nobilis* to *Plagionotus*.—Reprint.

† *Astriclypeus* (Japan), *Pygorhynchus* and *Agassizia* (W. Indies) must now be omitted.—Reprint.

bean Fauna, by a large number of peculiar American genera, having allied species in each, and by many analogous species in cosmopolitan genera. This close relation between the two faunæ may, also, be well shown by the large number of Indo-Pacific genera that are equally absent from both, although widely diffused through the Pacific and Indian Oceans, of which the following are examples: *Ophiopoeza*, *Ophiarachna*, *Ophiomastix*, *Ophiarthrum*, *Ophioplocus*, *Trichaster*, *Culcita*, *Anthenia*, *Archaster*, *Nardoa* (*Seytaster*), *Goniocidaris*, *Phyllacanthus*, *Echinothrix*, *Salmacis*, *Temnopleurus*, *Helicoidaris* (restricted), *Heterocentrotus*, *Acrocladia*, *Hipponoë*, *Laganum*, *Rumphia*, *Lobophora*, *Echinolampas*,* *Marelia*, *Desoria*.

The apparent absence of *Comatulide* and other Crinoidea is, at present, a remarkable feature of the Panamian Fauna. It is quite probable, however, that species of this group will be discovered hereafter, since they occur in considerable numbers, both in the Indo-Pacific and Caribbean Faunæ, as well as in the temperate and arctic portions of the Atlantic.

Future discoveries are likely to modify to some extent the details in the distribution of the genera here given, but it is not probable that the general arrangement of the generic types will be essentially changed, or that the conclusions arrived at can be much modified, for species that may hereafter be discovered are quite as likely to belong to West Indian or cosmopolitan genera, as to those peculiar to the Pacific and Indian Oceans.

In the above discussion the Holothurians have been omitted because quite a number of the species known to me from each fauna are still undescribed, and because there are good reasons for supposing that there are many Panamian forms that have not yet been collected, such as *Synapta*, *Chirodota*, and other species that burrow, or seek hiding places. Nor have the Holothurians of other tropical regions been so thoroughly collected as to make detailed comparisons possible.

To the geologist one of the most interesting questions connected with the study of the Atlantic and Pacific faunæ of tropical America, is the possibility of a direct connection of the two Oceans, across the Isthmus, during late geological periods. Such a connection has been suggested by some Geologists, upon theoretical grounds, to account for the coldness of the climate in North America and Europe, during the glacial period. The only direct, geological evidence of such a connection, that has been adduced, so far as known to me, is the

* Mr. A. Agassiz has described *Echinolampas caratomides* dredged by Pourtales off Florida,—Reprint.

occurrence in the miocene strata of San Domingo* of several species of shells having the closest affinity to those of the Panamian Fauna, and in some cases belonging to genera not now living in the Caribbean Fauna.† The majority of the associated species are peculiar, so far as known, to the formation, while nearly all of those identified with recent forms (14 species) still inhabit the West Indies. In the same formation 10 species of corals occur, none of which appear to be living, but most of them belong to European and Atlantic, rather than Pacific groups, except a species of *Pocillipora*, a genus not now living in the Atlantic, but common at Panama and throughout the tropical Pacific. In the paper referred to, it is stated that the Isthmus of Darien is less than 1000 feet high,‡ while the tertiary beds of San Domingo have been elevated nearly twice that amount.

A similar formation, and probably of the same age, occurs near Aspinwall in a railway cut, 15 feet above the sea-level,§ from which nine species are recorded as identical with those of San Domingo, and others are probably so. In the museum of Yale College there is a small collection from near Aspinwall, probably from the same locality, in which are specimens of a Clypeastroid, apparently identical with *Stoloniclypeus prostratus* of the West Indies, but certainly not with *S. rotundus* of Panama. So far, therefore, as the direct geological evidence bears upon this question it would indicate a passage of Pacific forms into the Atlantic during the Tertiary period, rather than the contrary. Yet Mr. Carpenter says,|| "As the level of the Atlantic is higher than the Pacific, any such communication must have poured the treasures of the Atlantic into the Pacific, and scarcely allowed an

* On some Tertiary beds in the Island of San Domingo; from Notes by J. S. Heniker, Esq., with remarks on the fossils by J. C. Moore. Quarterly Journal Geol. Soc. of London, vi, p. 39, 1849. On some Tertiary Deposits in San Domingo by T. S. Heneken, with notes on the fossil shells, by J. C. Moore, and on the fossil Corals by W. Lonsdale, op. cit., ix, p. 115, 1853.

(Mr. Duncan has since described the fossil corals in the same work,—Reprint.)

† The shells quoted as having close analogy with Panamian species are as follows:

"*Cassis*, scarcely distinguishable from *C. abbreviata*, Acapulco. *Malea*, closely resembling *M. ringens*, Coast of Peru (Panama, Yale Mus.), if it be not identical. *Columbella*, very like *C. pavona*, Gulf of California. The genus *Phos* of which several species are known in the Bay of Panama and none in the West Indies, is here represented by four species, all closely related to shells of the Pacific. *Venus*, nearest to *V. gnidia*, California (Mazatlan, etc.). *Arca*, a large species very like *A. grandis*, Bay of Panama: no large *Arca* is now found in the Atlantic."

‡ The lowest pass on the Isthmus of Panama is said to be but 287 feet,—Reprint.

§ Journal Geol. Soc. Lond., ix, p. 132.

|| Report of the British Association, 1856, page 363.

exchange in the other direction. Such is found to be the case; no species fairly belonging to the exclusive Pacific fauna being found in the West Indies."

The higher level of the Atlantic Ocean is, however, denied by others, and in consequence of the slight tides of the Atlantic side and their great rise and fall on the Pacific side, it is quite as probable that in case of a communication by means of a shallow or narrow channel, currents would flow alternately in each direction.

It is nevertheless very apparent that an intercommunication more or less remote between the two oceans cannot of itself account for the relations between the two faunæ, for should we assume that the small per-cent of identical species can be accounted for in this way, the occurrence of very large numbers of closely allied but distinct species, and also the agreement in generic and family types, already pointed out, still remain to be explained. This part of the subject presents much greater difficulties than the identity of a few species.

Two entirely distinct theories have been, and will doubtless long continue to be, adopted by naturalists in explanation of these facts and similar ones in various other regions:

1st. That the species and genera were created as we find them, and were originally adapted to the physical conditions and peculiarities of their respective districts. Consequently we should expect to find similar regions inhabited, to a greater or less extent, by similar genera and species.

2nd. That an extensive intercommunication took place at a remote period, and that the similar and allied species found upon the opposite coasts have originated by gradual differentiation from common ancestors, after the separation of the two oceans.

No. 4.—*Notice of the Corals and Echinoderms collected by Prof. C. F.*

HARTT, *at the Abrolhos Reefs, Province of Bahia, Brazil, 1867.*

Published, February, 1868.

THE collections of Radiata made by Mr. Hartt during the summer of 1867, while examining the coral-reefs which he had previously discovered upon the coast of Brazil,* having been submitted to me for examination, were found to contain so many species yet undescribed

* Mr. Hartt was a member of the party that accompanied Prof. Agassiz, in his celebrated Expedition to Brazil and, while making a special exploration of the coast, at that time first discovered some of the reefs near Santa Cruz and Porto Seguro.